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THE AGRICULTURAL STUDENT

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SOIL FERTILITY NUMBER

JANUARY 1915

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Silo Forms Were Used For This Circular Concrete Milk House

This concrete milk house, on the dairy farm of O. G. Sherburne, near Coldwater, Mich., was built with the same forms which contractors had used in building two 14x40 silos for Mr. Sherburne. Farmers who are having silos built can profitably use the roof and wall forms for a concrete milk house.

Mr. Sherburne's farm buildings are typical examples of the progressive farmer's preference for concrete structures. Twelve years ago his place had practically no improvements. Today it is a model dairy farm, with buildings permanently constructed of concrete.

Whenever you buy cement for concrete work, be sure to ask your dealer for

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Plants at Chicago and Pittsburgh

Annual Output 12,000,000 Barrels





Clover Leaf Lime HYDRATE OR CARBONATE

Is ground from rock high in calcium and is finished and packed with a knowledge of what is needed on the soil. If stored in a dry place it cannot deteriorate, so making it possible for the farmer to haul it from the railroad at any time and store for use when needed.

Clover Leaf Carbonate can be had in either bulk or sacks and Clover Leaf Hydrate in sacks only.

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Send for folders, giving analysis of our products and full description of the spreader.

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Courtland Bldg., CANTON, OHIO.

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The purchase and home mixing of fertilizer material saves from \$4.00 to \$8.00 per ton. Then, too, you know the sources of plant food are genuine and the best. No room for fraud. Home mixing is urged by all Experiment Stations, Agricultural Colleges, Institute Lecturers, etc.

We are the largest importers and distributors, and the pioneers of home mixing. We carry full stocks of Nitrate of Soda, Potashes, Acid Phosphate, Bone, Tankage, genuine Peruvian Guano, Basic Slag, etc., at all principal points at all time for prompt shipment. Write for quotations and our booklet on "HOME MIXING—HOW AND WHY."

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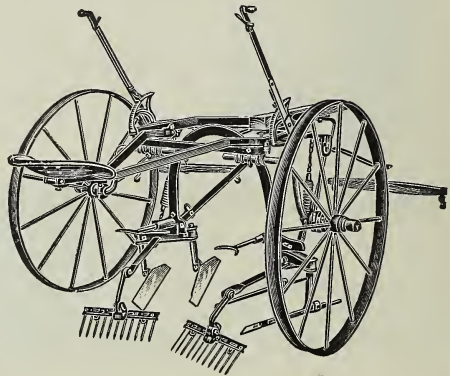
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W. G. & L. S. Griffith, of McNabb, Ill., breeders of Reid's Yellow Dent and Griffith's Early Dent Corn, wrote us on Feb. 16, 1914, as follows:

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Messrs. Griffith won the Grand Champion Prize at the State Corn Show in 1912. In 1913 their seedhouse burned, and that year John W. Rapp, of LaMoille, Ill., an exclusive Tower user for twenty years, won the Champion Sweepstakes and First Prize for the Northern Division.

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THE
**J. D. Tower
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And you will certainly want to use the lime which is the best and least expensive.

MARBLE CLIFF Agricultural Ground Limestone

has the right elements and by proper application will bring the best results. It is economical because of its well balanced properties and advantageous freight charges.

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THE MARBLE CLIFF QUARRIES CO.

Hartman Bldg., Columbus, Ohio

Announcement

THE FARMERS FERTILIZER COMPANY has enlarged its scope of usefulness to the farmer. We now manufacture or distribute:

First—FARMERS BRANDS of fertilizers of the same high quality as heretofore. (Seven potash brand.)

Second—FARMERS 60 PER CENT DIGESTER TANKAGE (with blood meal), will increase your profit in hogs one-third.

Third—AGRICULTURAL LIME (98% pure), direct from our West Columbus quarries.

Fourth—LEGUGERM, a bacteria for the inoculation of ALFALFA (direct from Laboratory to Farm).

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Sixth—EVERLASTING CLAY DRAIN TILE, manufactured from the excellent clay deposit on our property in Northeast Columbus and on which our fertilizer plant is located.

Quality in all products will continue to be the first consideration.

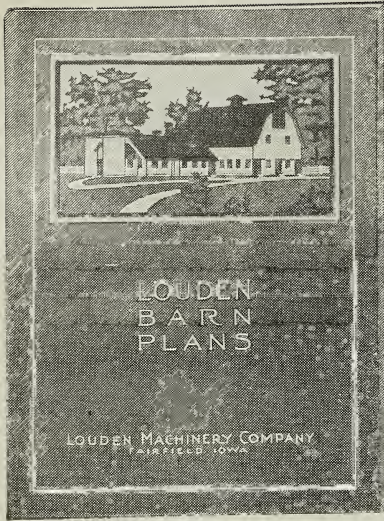
The new policy eliminates needless expense and the benefit of this saving is reverted in the hands of the farmer in the low prices offered. Let us quote you direct, or tell you about our FARMERS AGENCIES Proposition.

Write for our literature. It will interest you.

The Farmers Fertilizer Company

COLUMBUS, OHIO, P. O. BOX 96.

Factory $\frac{3}{4}$ of a Mile Directly East of the State Fair Grounds.



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I would like your catalog of.....hay tools,barn door hangers,lit-
ter carriers,feed carriers,stalls and stanchions. (Check catalog wanted)

Name.....

Town.....

StateR. F. D.....

More Potash Coming

American crops and soils are still as hungry for Potash as before the outbreak of the European War, which curtailed the Potash shipments.

Some of the Fertilizer Companies are trying to induce farmers to buy the one-sided low Potash or no Potash fertilizers of a generation ago. This means a fertilizer that is profitable to the manufacturer, but not the best for the farmer. When the Syndicate in 1910 started the direct sales of Potash to dealers and farmers at reasonable prices, Potash sales increased 65 per cent. in one year, a clear proof that farmers know that Potash Pays. They know that Potash gives good yields, good quality and resistance to plant diseases.

Many of the Fertilizer Manufacturers are willing to meet the farmer's wishes and sell him what he thinks he needs. These manufacturers are now willing to furnish as much Potash as they can secure. They offer goods with 5 per cent and even in some cases 10 per cent Potash, if the farmers insist on it.

Shipping conditions are improving, more Potash is coming forward, although the costs of production and transportation are higher. The higher price of fertilizers is not due wholly to the slightly higher cost of Potash. Much of the Potash that will be used in next spring's fertilizer had reached America before the war started.

There is no substitute for Potash.

We can no more return to the fertilizer of twenty years ago than we can return to the inefficient farm implements or unprofitable livestock of that period.

H. A. HUSTON

Agricultural Lime

Hydrate or Caustic
Quick in Action—Lasting in Effect

AGENTS WANTED EVERYWHERE

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CLOVER SEED

COMMON RED	ALSIKE
MAMMOTH RED	CRIMSON
WHITE DUTCH	ALFALFA
WHITE SWEET	

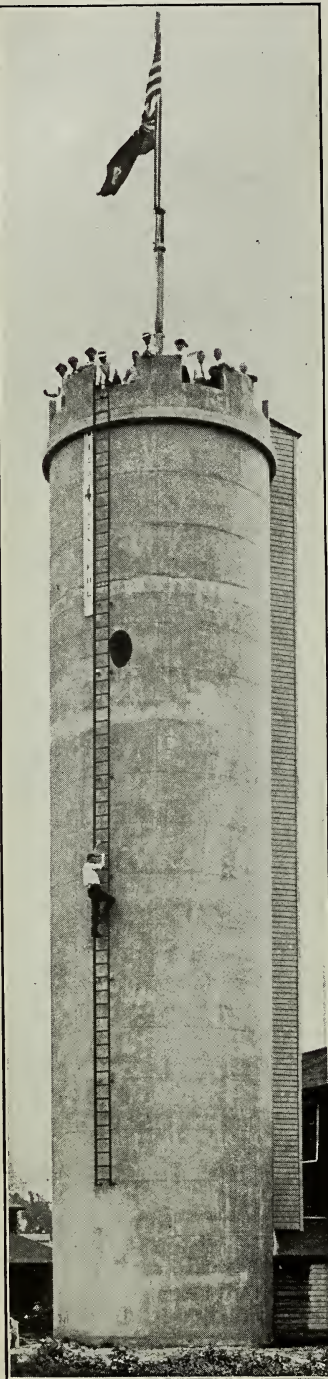
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Our Motto, "Quality First."

Quotation and samples on any of above seed cheerfully furnished on request. New 128 page Catalog free.

The Livingston Seed Co.

Dept. S—COLUMBUS, O.



Here's a Good Resolution

I hereby resolve that I will make a thorough investigation into my need for a silo. I will base my decision upon the results of tests made at experiment stations and agricultural schools, and upon the testimony of my friends who feed silage.

I further resolve that, if I should determine to build a silo, I will make an impartial investigation into the merits of the various kinds and makes of silos, and that I will choose the type that promises the most efficient silage-keeping service for the fairest amount of money. I will consider DURABILITY, UP-KEEP, and COST PER TON OF STORAGE CAPACITY. I will see to it that my silo is TRULY CHEAP, not cheaply cheap.

I finally resolve that I will start my investigation immediately by sending a request for silo information to the manufacturers of the POLK SYSTEM MACHINES for monolithic concrete silo construction.

The POLK SYSTEM monolithic concrete silos are the best for this fundamental reason: Every detail of POLK SYSTEM MACHINE design and every tiny specification in POLK SYSTEM SILO plans are designed to produce for the farmer a PERFECT, DURABLE SILO.

Polk-Genung-Polk Company

FORT BRANCH, INDIANA.

"They are not built of pieces, and they cannot go to pieces."



Watch Out When Your Animals Are On Dry Feed

GILBERT HESS, Doctor of Veterinary Science, Doctor of Medicine

Right now is the most trying season of the whole year for farm stock; they have been taken off pasture, put on dry feed and thereby deprived of the natural laxatives so liberally supplied in grass; confined in stables with consequent loss of exercise and pure air.

In my lifetime experience as a doctor of veterinary science, many a time have I been called in to treat cases of chronic constipation, stocking of the legs, dropsical swellings, skin diseases; but the most common and dreaded ailment of all—especially among hogs—is worms, and all these troubles are most prevalent during the stall-feeding period—during winter and spring, when stock are off pasture. I want every farmer and stock raiser—I want you—to feed

DR. HESS STOCK TONIC

A Conditioner and Worm Expeller

feed it this winter at my risk—on my guarantee below. This scientific preparation contains tonics to tone up the animal's system and enrich the blood, laxatives to regulate the bowels and ingredients for expelling worms.

Right now is the time to feed Dr. Hess Stock Tonic, because it's the cow in the pink of condition that fills the milk pail, the steer with an appetite that lays on fat, the horse that digests its dinner that pulls on the bit, the hog that is well and worm-free that gets to be a 200-pounder in six months.

So sure am I that Dr. Hess Stock Tonic will put your animals in a thriving condition, make the ailing ones healthy and expel the worms, that I have authorized my nearest dealer to supply you with enough for your stock, and if it does not do what I claim, return the empty packages and get your money back.

Dr. Hess Stock Tonic is never sold by peddlers—only reliable dealers; I save you peddler's salary and expenses, as these prices prove: 25-lb. pail \$1.60; 100-lb. sack \$5.00; smaller packages as low as 50c. Except in Canada, the far West and the South.

Send for my book that tells all about
Dr. Hess Stock Tonic—it's free.

DR. HESS & CLARK, Ashland, Ohio

Dr. Hess Poultry Pan-a-ce-a

This is the time when egg prices are high and your hens ought to be making up for the small egg crop during moulting. Pan-a-ce-a tones up the dormant egg organs and makes hens lay. Also helps chicks grow. Economical to use—a penny's worth is enough for 30 fowl per day. 1½ lbs. 25c; 5 lbs. 60c; 25-lb. pail \$2.50. Except in Canada and the far West. Guaranteed.

Dr. Hess Instant Louse Killer

Kills lice on poultry and all farm stock. Dust the hens and chicks with it, sprinkle it on the roosts, in the cracks or, if kept in the dust bath, the hens will distribute it. Also destroys bugs on cucumber, squash and melon vines, cabbage worms, slugs on rose bushes, etc. Comes in handy sifting-top cans, 1 lb. 25c.; 3 lbs. 60c. Except in Canada and the far West. I guarantee it.

Who won the \$1000 and why?

In spite of the poorest corn year ever known, many farmers finished in our contest for the ten prizes of \$100 each for the best ten full-acre yields of shelled corn,

Grown on A·A·C· Fertilizers

in Ohio and Indiana; and the ten prize winners secured yields averaging 96.74 bushels shelled corn per acre. The average yield in these two states according to Government Bulletin 641. is 36 bushels, while the United States average yield is 25.8 bushels. In order words, by using good seed, good cultivation, good sense and good fertilizers

These men nearly trebled their state yield and nearly quadrupled the United States yield.

Good work! and good agriculture! Their names:

FIRST	\$100.	R. E. McAhren, Manilla Ind.	yield 115. bu.
SECOND	\$100.	P. P. Pope, Tontogany, Ohio	" 108. bu.
THIRD	\$100.	O. L. Hart, Greenville, Ohio	" 104.5 bu.
FOURTH	\$100.	W. A. Groshans, Hamlet, Ind.	" 103.5 bu.
FIFTH	\$100.	Norris McHenry, Elizabethtown, Ind.	" 93. bu.
SIXTH	\$100.	W. A. Withrow, New Richmond, Ind.	" 91.7 bu.
SEVENTH	\$100.	Calvin Collier, Bellevue, Ind.	" 91.5 bu.
EIGHTH	\$100.	W. A. Westfall, Poseyville, Ind.	" 89.9 bu.
NINTH	\$100.	Valantine Bender, Poseyville, Ind.	" 87.1 bu.
TENTH	\$100.	Wm. Frederick, Corydon, Ind.	" 82.5 bu.

TRY-A-BAG of fertilizer this year. Our brands are soluble and active, hasten maturity and improve quality. Send for complete story of the contest and ask for prices and terms. Agents wanted. Address:

*The American
Agricultural Chemical Company*

Cleveland, Ohio—Cincinnati, Ohio

Alfalfa and Clover Are Profit Crops

A Turned-under Cloved Sod Invariably Assures a

Bumper Crop of CORN

For success with **any** crop there should be in the soil an abundance of nitrogen and humus. The best, easiest, cheapest way to get these necessary elements is to grow Alfalfa, Clover, Vetch, Soy Beans or Cow Peas, inoculated with



Alfalfa—
Inoculated with
“Nitragin.”



Alfalfa—
Not
Inoculated.



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THE SIMPLEST SAFEST AND SUREST SYSTEM
OF SOIL INOCULATION FOR ALL LEGUMES



“Nitragin” is the trade-mark name for the germ that acts on the legume root, draws nitrogen from the air and converts it into plant food. As a result there is a uniform “catch;” the crop grows quickly; it is strong, hardy and healthy—deep-rooted—rich in food value. Meanwhile your soil grows richer for the nourishment of succeeding crops.

A green manure crop inoculated with “Nitragin” Pure Culture provides a **richer** humus in **far greater** volume than a non-inoculated legume.

Inoculate all Legume seed with “Nitragin” Pure Culture. Easy to apply; a boy can do it.

Get the Original, with the Armour Oval Label

This is the **original** Pure Culture—discovered by Nobbe and Hiltner, famous German bacteriologists. It has been perfected by twenty years of scientific testing. The germs come to you packed in a **granular** food—in a ventilated can—the **safe** and **satisfactory** way.

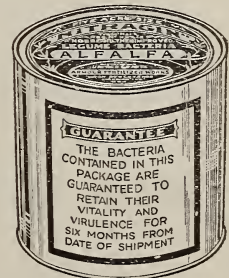
Let us send you complete information with proofs and endorsements by eminent agricultural authorities.

Prices per can: Garden size, \$1; acre size, \$2; 5-acre size, \$9. F. O. B. Chicago. Express extra. Parcel post, 10c per acre extra.

Order “Nitragin” from your Seed or Fertilizer Dealer and save postage and express charges.

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ARMOUR FERTILIZER WORKS, U.S. Yards, Chicago



Grind YOUR OWN Limestone--

And—to make sure it is **FINELY GROUND**
and **CHEAPLY GROUND** use the



Jeffrey Lime-Pulver

The Lime-Pulver is the first and only machine built which, in a single machine, handles **BIG ROCKS**, makes a **FINE PRODUCT** and **DISCHARGES DIRECTLY INTO WAGONS**, all **IN ONE OPERATION**, with only one handling of material.

**Made in Several Sizes--There's a Size to
Suit YOUR Engine**

Write for Information

THE JEFFREY MFG. CO.

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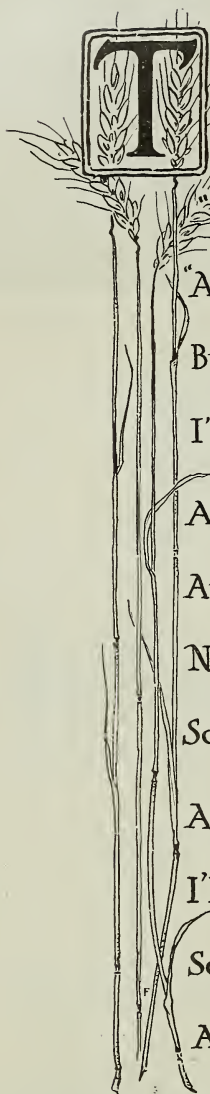
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THE WISE FARMER



HERE WAS a man in our town
And he was wondrous wise
He knew that if he wanted crops
He'd have to fertilize.

"It's nitrogen that makes things green"
Said this man of active brain;
"And potash makes the good strong straw,
And phosphate plumps the grain.
But it's clearly wrong to waste plant food
On a wet and soggy field;
I'll surely have to put in drains
If I'd increase the yield.

And after I have drained the land
I must plow it deep all over;
And even then I'll not succeed
Unless it will grow clover.
Now acid soils will not produce
A clover sod that's prime;
So if I have a sour soil,
I'll have to put on lime.

And after doing all these things,
To make success more sure,
I'll try my very best to keep
From wasting the manure.
So I'll drain, and lime, and cultivate,
With all that that implies;
And when I've done that thoroughly
I'll manure and fertilize.

THE AGRICULTURAL STUDENT

Vol. XXI.

OHIO STATE UNIVERSITY, COLUMBUS, JANUARY, 1915

No. 5

SOIL ANALYSIS AS A GUIDE TO TREATMENT OF LAND

CHAS. E. THORNE

Director Ohio Experiment Station

THAT portion of the food of the plant which it takes from the soil must be in the form of water solution. The plant has no stomach, in which it may subject its food to the solvent action of water reenforced by its own secretions, but its roots are fed by the water which percolates through the soil, and which we see in the crystal fluid of springs and running brooks.

The water of springs and brooks is of fairly uniform composition. The spring under a sandstone ledge may be "soft," that is, nearly or quite free from lime carbonate, while that flowing from a wall of limestone may be so heavily charged with this substance as to have left, in the course of the ages, great beds of marl when exposure to the air causes it to deposit a part of its burden; but the thirsty wayfarer drinks from the one spring as freely as from the other. True, in very exceptional cases the spring may be charged with an excess of some other material—as sulphur or iron—but these cases are so infrequent that they do not affect the statement that there are practically but two kinds of soil water—that containing lime carbonate with other minerals, and that relatively free of lime.

And why should it not be so? For myriads of ages the rain has fallen upon the soil and passed through or over it into the springs and brooks, and down these to the rivers, through them

to the sea, carrying with it the various salts which have been converted into soluble form by sunshine and frost and bacterial activity, until the sea has become an undrinkable brine and the land has become so leached of its salts that the water which flows from it is to us the water of life.

But is there not a difference in the strength of the soil solution? Does not a fertile soil owe its superiority to a larger proportion of the essential elements of fertility in the water which flows through its interstices? Certainly it does; but the difference between a deficiency and a sufficiency of available plant food in the soil is so extremely minute as to challenge the resources of the most elaborate chemical investigation.

For example, our analyses of the soil on which the experiments are located at Germantown show that it contains 33,520 pounds of potassium per acre. Corn, wheat and clover have been grown on this land in a 3-year rotation since 1894, and an application of 120 pounds of acid phosphate and 80 pounds of nitrate of soda to corn, followed by the same amount on wheat, has produced a 10-year average increase of 8 bushels of corn, 7 bushels of wheat and 716 pounds of hay, the average having a total value of \$13.88, if we rate corn at half a dollar per bushel, wheat at 90 cents, and hay at \$10.00 per ton.

When to this dressing muriate of potash has been added, at the rate of 20 pounds each on corn and wheat, carrying a total of 33 pounds of potassium, and costing \$1.00 for each 3-year rotation, the value of the increase has been raised to \$18.14, or by more than four times the cost of the potassium salt.

Thirty-three pounds is less than five ten-thousands of one per cent. of the weight of an acre of soil, taken to the depth of seven inches, but the results

into a form available to plants. It is certain that the solvent of these rocks is not so simple a fluid as rainwater; not even as rain water carrying the small proportion of carbon di-oxide which it may absorb in falling through the air or in percolating through the soil. The nitric acid evolved in the processes of nitrification no doubt serves to increase the solvent action of the soil water, and the adoption of "fifth-normal nitric acid" as a solvent is an at-

TABLE I.
A 10-Year Average Yield per Acre of the Principal Farm Crops in Ohio, with the Pounds of Nitrogen, Phosphorus, Potassium and Calcium Contained.

Crop and Yield Per Acre.	Nitrogen.	Phosphorus.	Potassium.	Calcium.
Wheat—13.21 bushels grain.....	15.66	2.76	2.81	.28
1,414 lbs. straw.....	7.46	1.28	11.74	2.73
Total	23.12	4.04	14.55	3.01
Oats—33.64 bushels grain.....	21.66	4.40	6.23	.84
1,508 lbs. straw.....	8.76	1.32	16.51	5.39
Total	30.42	5.72	22.74	6.23
Corn—36.61 bushels grain.....	36.04	4.90	6.97	.44
1,738 lbs. stover.....	14.15	1.16	13.55	6.35
512 lbs cobs.....	2.56	.13	3.27	.30
Total	52.75	6.19	23.79	7.09
Clover—2,200 lbs. hay.....	47.67	4.03	24.74	31.44
Alfalfa—4,500 lbs. hay.....	112.95	13.05	74.73	67.83
Timothy—2,250 lbs. hay.....	18.92	2.95	30.08	5.13

attained by two different analysts, operating under the slight differences in technique that prevail in different laboratories, may easily vary by several thousandths or even several hundredths of one per cent.

Moreover, chemistry has not yet uncovered all the secrets in the methods by which the mineral elements of plant food are converted from their insoluble condition in the pulverized rock, which constitutes the mineral basis of the soil,

tempt at following nature's method. But nitrification is not equally in evidence in all soils, and hence the soil water is not the uniform solvent that we make in the laboratory; moreover, back of the process of nitrification, and probably of even greater importance in the solution of the rocks, is the work of the *Azotobacter* and kindred organisms, inhabiting the water film which envelopes the soil particles and directly combining the nitrogen and carbon di-

oxide of the soil atmosphere with the phosphorus, potassium and other mineral elements of these particles.

The physical condition of the soil has much to do with its productiveness. A soil well stocked with organic matter is unusually more productive than one deficient in this constituent, which is partly due to the fact that the decaying organic matter of the soil contains not only nitrogen, but the mineral elements as well, in a relatively available form; and a soil of medium texture is more favorable to production than either a very coarse-grained or fine grained soil.

A crop of corn also consumes 50 per cent. more phosphorus and potassium and two and one-third times as much calcium as an equivalent crop of wheat, while a crop of clover, containing nearly the same amount of nitrogen and potassium as an equivalent crop of corn, requires no more phosphorus than a crop of wheat, but more than ten times as much calcium as does wheat, and more than four times as much of this element as a crop of corn.

Because of these differences it is to be expected that certain soils will be found better adapted to certain crops than others, and this is a matter of

TABLE II.
Pounds of Elements per Acre in Upper Six Inches.

Station.	Nitrogen.	Phosphorus.	Potassium.	Calcium.
Total:				
Wooster	1,778	664	33,110	4,720
Strongsville	3,600	880	41,320	5,100
Soluble in fifth-normal nitric acid—				
Wooster .....	....	4	144	882
Strongsville .....	....	12	272	2,160

In addition to these points, is the fact that different plants have different tastes in regard to this food, as is shown by Table I, which gives the pounds of nitrogen, phosphorus, potassium and calcium removed from an acre of soil by an average yield of ordinary crops as they are grown in Ohio, these yields being a 10-year average for the State, thus showing the relative production.

The table shows that a crop of corn consumes more than twice as much nitrogen as an equivalent crop of wheat, which is in line with common experience that corn is most successfully grown on a soil well stocked with this element.

common practical experience, although it does not follow that, because a soil is peculiarly adapted to a certain crop, that crop should be exclusively grown upon it; for the principle of crop rotation comes in here, and it is frequently necessary to grow a crop which yields a minor profit in itself in order to maintain a systematic rotation.

Since 1894 at Wooster and since 1895 at Strongsville the Ohio Experiment Station has conducted experiments in the use of fertilizers on crops grown in a 5-year rotation of corn, oats, wheat, clover and timothy. The soil at Wooster is a fine-grained, silty clay,

lying over the upper sandstones of the Waverly series, from which it has been largely derived, though modified by glacial action. That at Strongsville is a clay largely derived from argillaceous shales lying lower in the Waverly series, and is much more plastic, drying out much more slowly after be-

the increase from treatment for the 20 years at Wooster and the 19 years at Strongsville ending with 1913.

Table III shows that, notwithstanding the higher proportion of all the fertilizing elements in the Strongsville soil, the unfertilized yield of all the crops, except oats and clover, has been

TABLE III.

Average Unfertilized Yields and Increase from Fertilizing Elements for 20 Years at Wooster and 19 Years at Strongsville.

Crop and Station.	Average Unfertilized Yield.	Treatment and Increase Per Acre.		
		Phosphorus.	Phosphorus & Potassium.	Phosphorus, Potassium & Nitrogen.
Corn, bushels..... { Wooster	28.95	7.78	14.40	18.66
{ Strongsville	26.09	8.54	10.10	11.86
Oats, bushels { Wooster	30.03	8.79	12.52	18.93
{ Strongsville	35.08	9.40	9.85	13.28
Wheat, bushels ... { Wooster	10.70	7.58	8.76	15.93
{ Strongsville	7.15	6.49	7.56	9.21
Clover, lbs..... { Wooster	1,813	515	971	1,407
{ Strongsville	1,959	928	623	849
Timothy, lbs..... { Wooster	2,622	310	512	988
{ Strongsville	2,254	273	455	504
Average Annual Value of Increase for Entire Rotation.				
Total { Wooster .....	....	\$3 30	\$4 94	\$7 86
{ Strongsville .....	....	3 50	3 78	4 74.
Net { Wooster .....	....	2 78	3 12	3 26
{ Strongsville .....	....	2 98	1 95	04

Computing corn at 40 cents per bushel; oats at 30 cents; wheat at 80 cents; stover at \$3.00 per ton; straw at \$2.00, and hay at \$8.00.

ing wet. The chemical analysis of these two soils is given in Table II.

The Strongsville soil is higher in all the essential elements of fertility, especially nitrogen. It would seem that this should be a much more productive soil than that at Wooster. The actual results attained are shown in Table III, which gives the unfertilized yield and

smaller at Strongsville than at Wooster. Phosphorus though found in larger quantity in the Strongsville than in the Wooster soil, has produced a greater total increase at Strongsville than at Wooster. Nitrogen and potassium, however, have been less effective at Strongsville than at Wooster; and the total yield produced when these

elements have been added to phosphorus has been very much smaller at Strongsville than at Wooster in all the crops except oats.

Both these soils are acid, thus indicating that the calcium found is not in the form of calcium carbonate; and in fact the treatment of both soils, previous to the beginning of these experiments, had been such as to draw heavily upon both phosphorus and calcium; by pasturage at Strongsville and by the removal of the entire crops — grain, straw and hay — at Wooster. This previous history throws more light on the present needs of these soils for phosphorus and calcium than does chemical analysis, but neither previous history nor chemical analysis is a satisfactory explanation of the comparative ineffectiveness of nitrogenous and potassic fertilizer at Strongsville.

The Paulding county experiment farm is located on a tract of flat, black land, originally covered with water for weeks at a time and occupied with a semi-aquatic forest growth, consisting largely of elm. Within a recent period the saw timber has been cut off and removed from the land and the refuse burned upon it, and the water level has been lowered by the opening of larger ditches into which tile drains have very recently been led, the tiles usually being four to six rods apart.

Under such conditions there has been an extremely small waste of the elements of fertility, either by washing or leaching, for the water which has

flowed over the land has moved so slowly that it must have precipitated the larger part of any salts contained, while the quantity which has passed through the soil and into the drains has also been filtered of the elements of plant food which it may have dissolved out of the surface layer of soil. Moreover, the forest crops which have grown upon this land have for ages been pumping up solutions of the fertilizing elements and returning a large portion in the annual crops of leaves. Such a history should give promise of a very fertile soil, and our analysis of this soil shows it to contain 7,440 pounds of nitrogen per acre in the upper six inches, together with 1,958 pounds of phosphorus, of which 428 pounds is soluble in fifth-normal nitric acid; 39,000 pounds of potassium, of which 502 pounds is soluble, and 10,490 pounds of soluble calcium, part of which is in the carbonate form.

On such a soil it would not seem rational to expect any effect from fertilizers: what has happened has been that where phosphorus has been used alone, or with potassium only, there has been no regular increase of crop, but when nitrogen has been added to these two elements, in nitrate of soda, there has been a decided increase in yield.

From these results we must conclude that, while soil analysis may give us useful information respecting the total store of fertilizing elements in the soil, such analysis is not by itself a sufficient guide to the treatment of the land.

LIMESTONE—THE SOIL MEDICINE

ALFRED VIVIAN

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THE soil is the stomach of the plant. Just as the food of the animal is digested and made soluble in the stomach, or more broadly speaking in the alimentary tract, so the food of the plant is digested and made soluble in its stomach—the soil. Animal stomachs sometimes fail to work properly, and the food is then not fully digested. No matter how much food the animal takes into its stomach, if the food re-

monly termed. During this working over of the organic matter the bacteria form various organic acids, similar to the acetic acid of vinegar, the lactic acid of milk, etc. Finally, the carbon of the organic matter is converted into carbon dioxide, and the nitrogen into nitric acid. If this desirable process is to continue, it is necessary for the soil to be supplied with carbonate of lime so that these acids will be neu-



ONE METHOD OF APPLYING LIME.

mains undigested, the animal body receives no nourishment from it. Indigestion, or inability to digest food, is a commonly recognized disease of the animal stomach, but comparatively few people realize that the soil, the plant's stomach, may be affected in much the same way.

The digestion of the plant food in the soil is brought about by bacteria. The most evident work of these bacteria is their action on the organic matter of the soil by which they bring about its decomposition—or decay as it is com-

tralized as fast as they are formed, for the acids which the bacteria themselves produce will in time inhibit the bacterial action if allowed to remain unneutralized. When all the carbonate of lime in the soil has been exhausted in neutralizing the acids formed by the bacteria the soil becomes "sour;" the bacteria can no longer work properly; and the stomach of the plant is affected with indigestion.

Right here attention should be called to the fact that it is neither possible nor desirable to prevent the formation

of acids in the soil. All good farm practice, in fact, tends to increase the amount of acid formed in the soil. We plow and cultivate, partly, at least, to increase bacterial action, and thereby to hasten the decay of the organic matter and promote nitrification. But the more we hasten nitrification the faster acid is being formed. The more manure we use, the more green crops we plow under, by just so much do we increase the organic matter which the bacteria can convert into acids. And

will be sour tomorrow or next year, and those which may remain "sweet" a thousand years—all depending upon the natural supply of carbonate of lime. Let us not, then, lie awake worrying for fear this practice or that will cause acidity, but learn to recognize the disease when it appears and apply the sure remedy—which is lime in some form.

The clover family will tell us when lime is needed. Red clover and alfalfa are particularly sensitive to the lack of



GRINDING LIMESTONE WITH A SMALL PORTABLE PULVERIZER.

yet everyone knows that the use of stable manure and green manures is good practice. It might be said that the better the farmer the more acid he is causing to be formed in his soil.

From what has been said it must be evident that all soils tend to become acid, and in all probability every soil will some day be sour. If the soil is naturally very heavily stocked with carbonate of lime it will be many generations before acidity will develop, while the soils low in limestone are very soon made sour. Thus we have soils that are sour today, those which

carbonate of lime in the soil. The bacteria which grow in the nodules on their roots, and enable them to utilize the free nitrogen of the air, will not do their work in a soil which is acid. Some one has written

"If clover's sickly put on lime,

That will bring the soil to time,"

which is excellent advice if not very good poetry, for the failure to procure a good stand of clover is in nine cases out of ten due to a lack of carbonate of lime in the soil. The litmus paper test for acidity is strongly advocated, and it is safe to say that any soil which

will turn blue litmus paper red is decidedly in need of limestone. After all, the best way to determine if lime will be beneficial is to try it. A strip across the field limed at the rate of twenty pounds of builder's lime, or forty pounds of limestone to the square rod, will decide the matter. Why guess when it is so easy to get positive information?

If the soil is acid in what form shall the lime be applied? The three forms commonly used are (1) quick lime or

the haul is too long and the freight charges excessive, ground limestone should provide the necessary lime at the lowest cost. It is a much more pleasant substance to handle, as the dust is not so irritating to the skin and eyes as that from either the quick lime or hydrated lime. In some states the railroads give a very low rate on ground limestone to encourage its use, and in at least one state the penitentiary prisoners are employed in grinding limestone to be sold to the farmers at



EFFECT OF LIME ON SWEET CLOVER AT WOOSTER.

The Center Plot Was Not Limed.

builder's lime, (2) hydrated or slaked lime and (3) carbonate of lime or limestone. Quick lime has greater power to neutralize acid than either of the others. The ratio of neutralizing power is, in round numbers, about as follows: One ton of quick lime is equal to 2700 pounds of hydrated lime, or 3600 pounds of limestone. There is some difference of opinion as to which is the best form to use. Limestone, however, is steadily growing in favor as a material to correct soil acidity. Unless

cost of production. Ground limestone is "fool proof" and there is no danger of doing harm with it. The low priced pulverizers now on the market make it possible for the farmers to grind their own limestone in sections where outcroppings of the stone are found adjacent to acid soils. Unfortunately, however, there are many sections needing lime which, lacking a home source or supply must depend on material shipped from a distance. It would pay the railroads to make special rates on

limestone to such acid districts wherever found.

A special lime spreader is needed to apply lime or limestone. The fertilizer drill has not sufficient capacity. Many good spreaders are made which will apply the limestone in quantities varying from 500 pounds to five or six tons to the acre. The amount of limestone needed depends upon the degree of acidity. The average application is about two tons to the acre. Such an application will last five or six years when it must be renewed. Probably the best place in the rotation to use the limestone is on the ground plowed for corn. It can then be harrowed in and thoroughly mixed with the soil during the cultivation of the corn. Used in this way it has time to destroy the acids before the clover is seeded, and a good stand of clover (or other legume) is absolutely essential to successful agriculture. "Was it not Mr. Williams who said, "Unto the farmer who can grow good clover all things else shall be added?"

When the soil needs limestone nothing else will take the place of it. More than that, it is foolish to add valuable plant food to a soil which is so acid that the food cannot be digested. The first move, then, in the case of a sour soil is to overcome the acidity by adding limestone. That it pays to do so is amply proven by experiment. The following figures published by Director Thorne in Bulletin 279 show the value of the increase per acre from one ap-

plication of lime on the acid soil at Wooster.

	Value of increase
Corn	\$ 5.12
Oats	0.57
Wheat	3.18
Clover hay	5.28
Timothy hay	5.88
Total	\$20.03

It should be remembered that this gain came from the use of lime in connection with a good scheme for fertilization. Most disappointments in the use of limestone are due to the fact that it was apparently thought to be a universal panacea. Limestone has one task to do in the maintenance of fertility and it does that well—but it is unreasonable to expect it to take the place of everything else. It was the use of lime to the exclusion of all other materials that brought it into disrepute and caused the English farmer to say:

"Lime and lime without manure
Makes both farm and farmer poor."

The rational use of limestone as a cure for soil indigestion is another story. When limestone is used on acid soils in connection with stable manure, green manures and commercial fertilizers it aids in soil building and not in soil depletion. We are, therefore, justified in bringing the old proverb up to date as follows:

"Limestone, phosphate and manure
Clover, grain, and grass assure."

DRAINAGE AND SOIL FERTILITY

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TOO much water in soils is detrimental because: (1.) It makes areas so soft that they cannot be cultivated. When these soft areas are long and narrow in form, they cut the upland into irregular pieces that cannot be cultivated conveniently. (2.) It delays cultivation, particularly in the spring. (3.) It makes the soil cold; (a) because in the spring more than half of the heat that the soil receives is used to warm this unnecessary water; (b) because the evaporation of the water consumes heat that the soil should otherwise retain; and (c) because its presence in the soil prevents the entrance and downward movement of rainwater, which in the spring is usually warmer than the soil. (4.) It crowds the air from between the soil grains, thus hindering the necessary decomposition of organic matter in the soil. (5.) It prevents the deep root development of plants.

The water table in the soil is indicated by the height to which water will rise in an open post hole. When the water table is only a few inches below the surface of the ground during the spring, farm crops do not find it necessary or to their liking to send their roots down more than a few inches into the ground. A period of drought lowers the water table in the summer and these shallow rooted plants suffer severely and may die for want of water. When a timothy sod dies in this way farmers are apt to attribute it to too much drainage. The real reason is that there was not enough drainage during the spring when the root system was developing. The fact that good results frequently follow the

construction of dams in ditches during the dry part of the summer proves nothing to the contrary. This is but the sub-irrigation of a dry soil with water coming from a distant source, and deep drainage during the spring renders this irrigation the less necessary.

At the Wisconsin Experiment Station corn has been grown in cylinders containing similar soils, but with the water table at different heights. The photograph shows part of the results, none of which have been published yet. A much better root system has developed where the drainage was 48 inches deep than where it was only 4 inches deep. In the one case the roots penetrated a volume of soil about ten times as great as in the other. In a soil containing only a small amount of plant food this would make a big difference in the amount of nutrients available to the growing plant.

Unlike field conditions on an average season, the water table was kept at the height indicated during the entire period of growth. If the water supply were cut off and the water table lowered in the cylinders the plant on the right would have had its growth limited by drouth. It may be argued that the maintenance of a high water table was beneficial to the plant on the right. This must be granted, but it is only because of improper drainage at the beginning of the growth that the maintenance of a high water table is necessary later.

An interesting development in this experiment is that when the high water table was maintained by adding water at the top of the cylinder, the

roots were found to reach down into the water. When the water is added at the bottom from a supply of stagnant water, the roots are seldom found below the top of the water. It appears that it is the air carried down by the water when applied at the top that

wick is always present to hold in the soil as much water as the plant can use. More water than this would be injurious, and less than this is found only in soils too dry to admit of further drainage. Happily the force of capillarity fixes the limit of drainage, up to which drainage is necessary and beyond which it is impossible.

Generally it is impossible to drain a soil too deep. The vast majority of our fields are supplied with capillary water by the temporary water table and not by the general water table. Ordinary rains falling on a dry open soil are swallowed up as capillary water. Heavier rains falling on a wetter and tighter soil cause the water to accumulate on the soil faster than it can be taken up as capillary water. This causes a zone of the soil to become saturated. The top of this saturated zone is the temporary water table. It moves downward to the general water table if it is not used up in transit by replenishing the intervening soil with capillary water.

The deeper a drain is, the farther down the temporary water table is permitted to go before the drain is reached and any water is lost. After the temporary water table has fallen below the drain, the drain dries up. Some useful water may be lost while the zone of saturation is passing the drain, but that is more than compensated for by the drain in preventing the general water table rising too high during extended wet weather.

Coarse sandy sub-soils dependent on the general water table for their capillary water can be drained too deep. It may be impossible for sufficient water to rise by capillarity through four feet of such soil. In that case drains four feet deep are too deep. If but three feet deep, the gravitational



THE RESULTS OF A HIGH AND LOW WATER TABLE IN THE SOIL.

—Wis. Exp. Sta.

makes the deep rooting possible in the former case.

It is impossible to make a soil too dry by drainage. The force of capillarity that draws kerosene up the lamp

water in the fourth foot of soil can be saved to supply the upper three feet with water when the rainfall is insufficient. The coarser the soil the shallower the drain should be in the limited number of these special cases, but in no case should the drainage be so shallow as to interfere with proper root development.

Have you ever seen corn fields of a yellowish green during a cold June? That is because the soil is too cold to permit nitrification to proceed. Too much water retards nitrification, first by excluding the air, second by making the soil cold. All decomposition is retarded by poor drainage. That is why undecomposed peat decomposes so slowly. It is literally pickled in the water saturating the soil. Four feet of raw peat containing but little available plant food has been known to settle to less than three feet of solid, black, fertile soil with five years of drainage.

Did you ever stop to think of the loss of fertility due to the hard lumps found during wet season in so many cornfields? In every one of those big lumps there is plant food locked up so that the plant can not get at it. Poor drainage is the chief cause of the formation of those lumps. In the northern part of Wisconsin there is a red clay soil called Superior clay. It is naturally a tight soil, but upon tiling it checks and cracks so that

water gets to the tile easily. Ten years of tile drainage has improved the workability of this soil to a marked degree. Formerly it was frequently so lumpy that the entire furrow slice was a mass of lumps, too dry and coarse to permit the germination of seeds. It used to be too wet to plow until late in the spring, and then before it could be plowed, it was too hard and dry. The period during which this land can be cultivated properly, that is, the period intervening between the time when the soil ceases to be too wet to cultivate and the time when it begins to be too dry, is longer than formerly.

This paper merely hints at a few of the relations of drainage to fertility, but we must not omit mentioning the wet spots in so many fields that are plowed, and harrowed, and seeded every year, but produce a crop only about once in three years. Labor expended in cultivating these spots is wasted, so the land is worse than worthless. Its fertility is below the zero mark. Drainage would make these wet spots as productive as any in the field. The productivity of plot is a measure of its fertility. If only one crop in three is certain before drainage, and three crops out of three are certain after drainage, the factor of drainage amounts to 67 per cent of all of the factors determining the fertility of the plot.



SOIL FORMATION AND CROP PRODUCTION

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THE variability of soils in the field is recognized by every observing person and some connection is perceived between those variations and the growth of crops. The variations range in fineness from clay to sand and gravel; in structure from loose and open to compact and impervious; in color from light shades of gray, yellow and red to black or deep shades of the prevailing

determines the capacity of a soil to produce plants. Differences in their adjustment are the cause of the difference in the type and quality of plants that grow best on each particular soil.

The properties of a soil are the result of the condition of its formation. Consequently, the adaptation of plants to soil may be said to be determined by the formation of the soil. The term



THE MODIFICATION OF ROCK TO SOIL IS A SLOW PROCESS.

colors; in organic content from almost none to those soils made up almost entirely of plant remains; in drainage from drouthy sand and gravel terraces to marsh and swamp conditions; in depth from nothing to hundreds of feet; in lime content from no free carbonate to many per cent of that constituent; and in plant-food elements from an abundance to serious deficiency.

This is an incomplete record of the primary physical and chemical properties of the soil, the adjustment of which

formation must be used here in the broadest sense to include all those processes and material both near and remote that have given the soil its present properties. They run through a long series of events and are as old as the rocks. In fact, soil has been described as rock in transition from one stage to another. In the main the modification of soil is a slow process.

The incidents in the formation of soil may be divided into two groups. The first of these is the kind or kinds of

material from which the soil is formed. The second is the agencies or forces that have acted upon that material to change its physical and chemical constitution and to transport, sort, mix and redeposit the residue.

The material:—The soil is fundamentally a mass of fragments of rock and a little organic matter mixed with water and permeated more or less by air. From the particles the essential mineral elements of plant food are derived. The availability of the elements depends on the kind of rock from which the particles were formed. The mineral plant-food elements are unequally distributed in the rocks. Some sandstone is so nearly pure quartz that it contains only four or five per cent of other constituents. Shale and slate rock may be very deficient in phosphorus and lime. Limestone may be either exceedingly rich or exceedingly poor in phosphorus. The so-called original or crystalline rocks have a strong similarity in ultimate chemical composition, and if all soils were derived directly from them without loss of elements soils generally would be moderately well supplied with mineral food elements. It is evident that with a great variety of rocks in the groups mentioned above, there may be any proportion of any or all of them in some soil. Should it happen that a soil is derived from the lean sandstone, it must inevitably be lean in food elements.

Not only the chemistry of the rocks is important but their physical nature is equally to be considered. The soil mass by reason of its texture or fineness and structure, holds water. If, therefore, the soil were derived from a coarse gravel rock without important change of the crystals the soil would be coarse and open. Similarly, from a fine rock and especially if the minerals

were such as are easily reduced in fineness by decay and abrasion, the soil would be very dense and clay-like. Such fine material holds water tenaciously. It inclines to be sticky when wet and compact, and hard when dry and exhibits a wide range of properties commonly associated with heavy clay soils. If different minerals undergo unequal decay or destruction, the soil may be a mixture of coarse and fine material, a loam or a sandy loam.

The forces:—Like the question of whether food or drink is more important to the animal, so it is difficult to say whether the material from which a soil was formed or the processes by which it was formed is more important.

By forces we mean all those agencies that operated to destroy rock masses and to mix and redeposit the residue in unconsolidated masses that are known as soil. These forces may completely efface the characteristic properties of the original rock from the soil. They may remove the more important elements and change the physical form, size and shape of the particles. While, therefore, the original material must be taken into account, it is even more important to know the forces that have been operating to form a soil.

These forces may be divided into several groups, according to the predominant type. They can not be sharply separated for they incline to go together.

1. Weathering. This includes all those processes of decay by which rock masses are broken down. It includes hydration, solution, carbonation, leaching, erosion and other changes. The least resistant minerals are broken down and the more soluble elements removed. The residue left from this process is a residual soil. If the rock were uniform in character and position,

decay would go on uniformly. If deeply decayed the soil would be deep and perhaps productive. If shallow the soil would be less productive. If there were hard streaks, as of chert in the rock, the soil would be stony and uneven in productiveness. The soils of south-eastern Ohio illustrate residual soils chiefly from shale and sandstone.

The remaining forces are all characterized by marked change in position of the material and the extent to which

sorted them according to fineness. Pure gravel, sand and clay to a large extent are the result of sorting and deposition by water. Where the current is swift, only coarse material is laid down. It is loose and porous and because of its low capacity to retain water is leached and drouthy. Further, water inclines to form level plains that are favorable to agricultural operation. On the other hand, when streams are set to cutting they are the most rapidly



THE MOST IMPORTANT AGENCY OF TRANSPORT IS WATER.

it has been mixed or sorted. They may be grouped as the agencies of soil transport.

2. Gravity is one of these appreciably operative in mountain regions, but alone is not of much agricultural importance.

3. The most important agency of transport is water which has been more operative than any other to form the configuration of the earth's surface. In the form of streams, currents, waves and quiet pools, it has actively destroyed rocks, mixed the products irrespective of chemical composition and

destructive agent and cut the surface to great roughness. Frequently the plains once formed are later destroyed by streams, forming benches or terraces.

4. Wind appears to have had a considerable part in soil formation, especially if the fine loess soil of the middle-west and other extensive areas in the world are allotted to that agency. No soil has more ideal texture for a wide range of crops. The range of fineness of wind sorting is much smaller than in water. The mixing is more thorough. Such a soil is more homo-

geneous and, therefore, of more uniformly good composition. It is predominately a fine sand to silty clay without a pebble or boulder to obstruct tillage. Not having been much subject to washing, it is usually rich in lime.

5. Glacial masses of ice slowly moving down from higher latitudes or altitudes have been especially active in soil formation in the northern hemisphere. Ohio owes its chief agricultural advantage to that epoch which leveled its surface and introduced large areas of good soil.

The chief results of this force are the indiscriminate grinding of rock to soil powder without leaching or loss of plant-food, also the indiscriminate mixing together of coarse and fine material. Such soils are generally rich in food elements. Sometimes, due to its large extent a single type of rock may impress its character on the soil. There are notable examples of this in Ohio and New York, especially the Volusia series derived by glacial action from gray shale low in lime and found south-east of Lake Erie.

The topography of glacial soil is notably smooth, often with basin-shaped areas in which are ponds and marshes filled with humous soil. Muck and peat areas in the northern United

States owe their development largely to this process.

In conclusion, a few examples of the correlation of the formation of soils to their crop adaptation may be noted. We take them from the field with which we are best acquainted.

Alfalfa in New York is naturally successful in a narrow belt of county in the middle of the state on calcareous, glacial soil. Early truck is grown on Long Island and adjacent to the larger cities on sandy soils deposited by water.

Nursery stock is grown on silt and fine sandy loam deposited in slow moving water near Rochester and Geneseo. Cabbage and beans are produced in the middle of the state where certain relations to lime prevail as a result of formative conditions.

Buckwheat, oats and potatoes come together on farms on the southern New York highland where the soil is relatively thin, poorly drained, wet and deficient in lime because derived by glacial action from shale rock low in lime.

The data presented are sufficient to indicate that one is not likely to have an adequate understanding of soil conditions unless he knows their formation, which give the cue to their present properties.



THE USE OF COMMERCIAL FERTILIZERS IN OHIO

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THE use of commercial fertilizer in Ohio is by no means universal. In some of the more fertile sections there are considerable areas where only occasionally can a farmer be found who follows the practice of applying purchased plant food to his soil. This is not surprising when one considers the attitude that is apt to be prevalent in a region where the soil compares favorably with any in Ohio in fertility and yet the men who are farming it use what will have to be called quite heavy applications of commercial fertilizers.

Outside of the more fertile sections there is a varying number of farmers who use very little if any commercial fertilizer. A small part of this group of men are cultivating river bottoms that are subject to overflow and it is easily seen that their problems differ from those of the men on soil which does not overflow. Of the remainder of the non-users of commercial fertilizers, there are some, no doubt, who get along without it because of necessity. They do not have the means to buy it even though they believe in its use. Others have no reason for using it or for not using it. These are either fairly well satisfied with their condition or else resigned to fate, have been content to take what they could secure by plowing, sowing, and reaping. The idea that it is possible to better the yields of their crops through the use of commercial fertilizers apparently have never made a very strong impression on them. The opponents of commercial fertilizers, who profess to see in it something harmful

to their soil, are still to be found but in decreasing numbers.

A few who do not use commercial fertilizer have reasons for this which are deserving of more or less respect. One reason sometimes given is that the tiller of the soil does not know what plant food is needed and rather than buy indiscriminately, he prefers not to buy at all. He, possibly, is as logical as the man who buys whatever his neighbor does or what some "trusted" agent wishes to sell him. Another reason is that fertilizer has been tried and did not give good results so its use was discontinued. Such a reason cannot be condemned altogether, but the questions that naturally arise in such a case are (1) how thoroughly the fertilizer was tried and (2) what were the conditions under which the test was made. One year does not tell much concerning the efficiency of any fertilizer treatment, and, moreover, seasonal and soil conditions may have caused the fertilized crop to be less than that which received no fertilizer. Therefore the man who says he does not use commercial fertilizer because he has found it unprofitable is likely to be mistaken in his reasoning.

The majority of Ohio farmers, however, use commercial fertilizers. They would like to secure a fertilizer which is adapted to their needs and which contains the proper plant food in proper form. To attain this they are studying experiment station results and are seeking information from various other sources. This is a hopeful sign but even with all this activity on

the part of the farmer one cannot help from being impressed with the fact that there is very little method in the present day use of commercial fertilizers on the average Ohio farm. Despite this fact, the yields on many Ohio farms are steadily increasing. Almost any fertilizer that is commonly used in Ohio will do something toward maintaining the general level of fertility in the soil. All the increase in crops must not be attributed to the use of fertilizers, however, because better drainage conditions and improved systems of tillage have been responsible for a considerable part of the increase.

in their fertilizer is relatively large, often as much or more than the phosphorus. Here is an apparent conflict, but a further analysis of the situation discloses the fact that our agricultural institutions have not been teaching that the potassium of clay soils is inexhaustible but rather have been trying to show the possibilities of the potassium supply in such soils when properly conserved. That it is possible to produce profitable crops on clay soils without the use of purchased potassium is shown by the number of men who are doing it. Hay sold from the farm, straw sold or unused, ma-



THIS PLOT OF GROUND RECEIVED NO FERTILIZER AND YIELDED 11.3 BU. OF WHEAT. THE SAME SOIL AS SHOWN ON OPPOSITE PAGE.

It is interesting to study the fertility conditions of the state and it is encouraging to note that the findings of the experiment station and the teachings of the agricultural college are borne out in practically every instance. From superficial observation it sometimes appears that this is not so, but a little study shows that it is. The use of potassium in fertilizers is a concrete example. It has been shown that there is a large amount of potassium in clay soils but despite this fact many farmers claim to be most successful in the use of fertilizers on such soils when the proportion of potassium

more leached by the rain—each of these has helped to drain the soil slowly but surely of its most available potassium. As a result the majority of Ohio farmers have a real or fancied need for potassium in the fertilizer and are thus buying it. This is true not only of the owners of sandy soils but also of the dark loams of western Ohio and the lighter clay of eastern Ohio.

A glance through the list of fertilizers for sale in Ohio shows that the majority of them contain nitrogen. While exact figures are not available it is probable that more than one-half

of the users of commercial fertilizers purchase more or less nitrogen. The farmer who buys one half or one per cent of nitrogen and pays an exorbitant price for it is still easily found. But, on the whole, the users of commercial nitrogen are beginning to consider the cost and the source of this element. Because of the fact that it is not easy to ascertain the source and because of the cost, many farmers have eliminated nitrogen from the fertilizer which they use. They appreciate the relation which clover and manure bear to this element.

tatoes and corn are rather commonly fertilized but the use of fertilizer on oats seems to vary largely in different communities. A few men top dress their timothy meadows with fertilizer.

The quantity of fertilizer used per acre varies greatly. The farmers who use from 75 to 125 pounds of fertilizer to the acre on corn and wheat are still plentiful. Perhaps 200 pounds is more nearly an average but some apply one half more or even double this amount. Potatoes, if fertilized, at all, are fertilized rather heavily. In Ohio there is at least one man who applies



THIS PLOT ADJOINS THE ONE SHOWN ON THE OPPOSITE PAGE, BUT IT WAS WELL FERTILIZED. THE YIELD WAS 27.5 BU. OF WHEAT.

It is scarcely necessary to say that the greater part of commercial fertilizer sold in Ohio is fairly rich in phosphorus nor to state the reason for this. Barring two sections of Ohio, each a rather limited area, the use of phosphorus is general. The farmers have noted its efficiency in crop production. Many farmers buy no fertilizing elements other than phosphorus. They have learned that it is the one thing needed to fit in nicely with the clover which they grow and the manure which they produce.

Of the common farm crops wheat is the most generally fertilized. Po-

one ton of fertilizer to the acre for potatoes.

In every community there are men who use sufficient fertilizer to maintain the fertility of their soils. If this fertilizer is used to supplement clover sods, manure, organic matter, and in some cases lime, the crop yields of these men are increasing. Such men are easily found. They are leaders and are setting examples which will be followed as their neighbors come to see the superiority of their crop yields. The use of commercial fertilizers in Ohio probably will increase greatly in the next few years.

CONSIDERATIONS IN PURCHASING COMMERCIAL FERTILIZERS

FIRMAN E. BEAR

Department of Soils, West Virginia University

WEST VIRGINIA is facing the problem of what to do with the worn hill pasture lands of the state. The land is too rolling for cultivated crops and is left in pasture to prevent erosion. Enough cattle or sheep are allowed to graze over the hillsides to use up what pasture is produced. It is generally believed that what these pastures need is a fairly liberal application of limestone and the addition of some acid phosphate or steamed bone meal with perhaps some nitrate of soda.

Doubtless if lime, manure and fertilizers were at hand the land could be made to produce much better crops of pasture and accordingly more pounds of beef. But manure is not available in sufficient quantities to make much of a showing. The question is, can the owners of these thin, acid soils afford to buy lime and fertilizers to increase the pasture?

At a recent meeting the subject came up for discussion. It was thought by some that it was doubtful if any great amount of fertilizer could be applied with profit. Seventy-five cents per acre was considered the maximum amount one could afford to spend per year. Others took the position that such small amounts were not worth while but that a liberal application was needed in order to make it profitable.

In order to approach a solution of this problem it is necessary to know two things: First, what is the present return per acre, and second, what per cent increase may reasonably be expected from the use of fertilizers.

A survey of the farms in the blue grass region of West Virginia showed

that the farmers calculated that $3\frac{1}{2}$ acres of land were necessary to maintain a 1000 pound steer from April until December. Strangely enough a survey of several counties in the section where blue grass has largely been replaced by broom sedge and wild grasses indicated that $3\frac{9}{16}$ acres were required per steer. However, the opinions of the men who made the survey were to the effect that five acres of land per steer would not be more than sufficient in the latter areas.

A gain of 200 pounds in a summer is all that can reasonably be expected of a steer. At 7 cents a pound this would bring \$14.00. A return of \$14.00 from 5 acres of land is \$2.80 per acre. The answer to the first question, then, is that at the present time an acre of land in the thin hilly sections of West Virginia gives a return of \$2.80 per year.

As to the second question it is generally conceded that an application of fertilizers to a permanent sod cannot be expected to have the effect that it would when applied to crops in rotation. In the latter case the fertilizers are thoroughly mixed with the soil and are more active. At least it would not be logical to expect fertilizers to give a higher percentage increase on pasture lands than on corresponding level lands.

The results of the use of fertilizers on worn, acid soils is shown by the work of the Ohio Experiment Station. Two plots chosen from the five year rotation will serve to illustrate. Plot 2 has received nothing but acid phosphate at an average of \$0.52 per acre

per year and is an example of the use of an element most deficient in the soil in question. The use of phosphorus alone has given a higher return per dollar invested than the use of any combination of fertilizers. Plot 17 received a complete fertilizer and gave the highest net profit per acre of any plot. In this case the return per dollar invested was much smaller than in Plot 2. The cost of treatment averaged \$3.52 per acre per year. Plot 2 showed an average increase of 32.8%. On Plot 17 the percentage increase averaged 69.6%.

The answer to the second question then is that we cannot expect an increase in the yield of pasture on worn hill land of more than 32.8% by the use of acid phosphate nor more than 69.6% by the use of the best grade of complete fertilizer.

Referring to our former figures we remember that an acre of thin pasture land will produce about \$2.80 of beef per year. Suppose that Plots 2 and 17 had been in permanent pasture we

would have had the following returns per acre:

	Plot 2	Plot 17
Value of pasture in beef, unfertilized	\$2 80	\$2 80
Percentage increase	32.8	69.6
Value of increase	\$0 92	\$1.95
Cost of fertilizer.....	52	3 52
Net profit	\$0 40	—\$1 57

These figures illustrate clearly that the complete fertilizer would have been used at a loss. The use of nothing but acid phosphate would return only \$0.40 per acre, little more than sufficient to pay for the expense of applying the fertilizer. The logical conclusion is either than we cannot afford to use fertilizers on thin, hill pastures or that it is necessary to sell the grass in some more profitable form than beef.

This emphasizes the importance of making a study of the problem before buying fertilizers. If one pays twice what a fertilizer is worth (and many farmers are doing this) it is a difficult matter to obtain a profit by their use on ordinary farm crops.



THE WEST VIRGINIA FARMER'S PROBLEM.

STATE CONTROL OF COMMERCIAL FERTILIZERS

S. K. JOHNSON

Chief, Bureau of Inspection, Division of Agriculture, Columbus, Ohio

THE end of this year, marking as it does thirty-three years of state control of commercial fertilizers in Ohio, has been a period of growth and real progress in the control laws of the state, with periods of inactivity due to failure to secure legislative amendments desired in order to meet commercial conditions. In the amendments proposed there was never anything embodied that could in a manner be considered as demands of a radical order.

The first law permitted manufacturers a deficiency of one percent in claims of ammonia, phosphoric acid and potash before evidence of fraudulent intent was presumed. This, if figured in accordance with average market quotations, would amount to \$5.54 a ton, or a subsidy to the manufacturer.

Investments in Fertilizer Plants:— In 1900, sixty million dollars represented the investment in fertilizer plants in the United States, while in 1914 this increased to one hundred and twenty-five million dollars. In 1913, seven million tons of fertilizers were consumed in the United States as compared with two million tons used in 1900. The amount of fertilizer used in Ohio is only a handful as compared with that used in some of the southern states, notably North Carolina, South Carolina and Georgia, which consume practically one-half of the fertilizer sold in the United States, while Ohio's total tonnage slightly exceeds one hundred and sixty thousand (160,000) tons per annum.

Sampling of Fertilizers:— Different states employ different methods in obtaining fertilizer samples for analysis.

Sampling is of as great importance as the analysis. Some states have inspectors draw samples from sacks filled at the fertilizer factory, while others, of which Ohio is included, secure them as prescribed by law from sacks that have not been heretofore opened, broken or resacked, and from shipments made to farmers, agents and dealers as well as from goods found in buildings, rooms, railroad cars, stores, storerooms, warehouses or other places within the state. Inspectors drive through the country canvassing for fertilizers delivered in that vicinity. Samples are not drawn by the hands, but by tubes that run full length of the sacks (see cut), thereby permitting inspectors to obtain samples of both fine and coarse particles of which the mixture is composed.

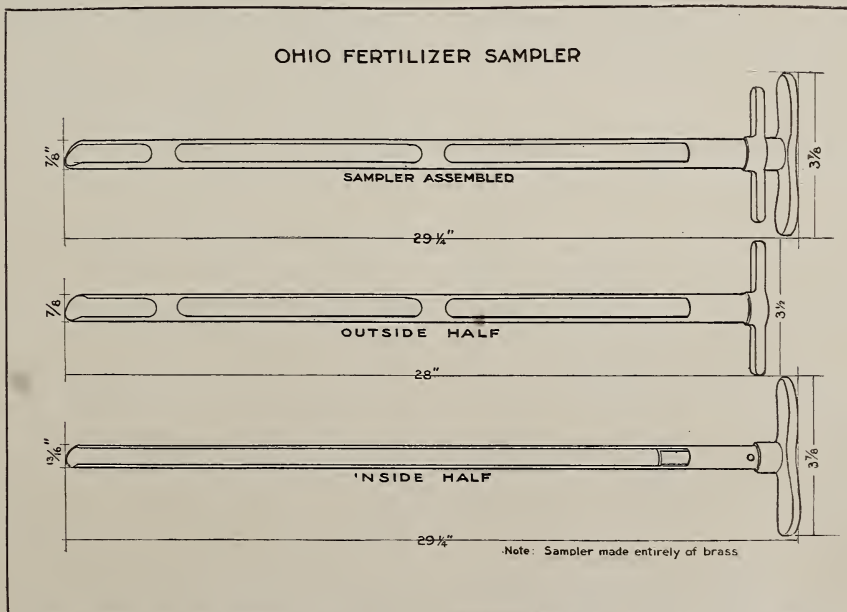
State Control Necessary for Pecuniary Advantages:—Pecuniary advantages in the production of farm and garden crops are secured by the judicious use of commercial fertilizers. This is universally recognized. Much of the success due to the use of fertilizers depends, for obvious reasons, on a favorable physical condition of the goods and a definite commercial composition of the fertilizing materials to be used, also a system of state inspection introduced to secure the desired information. Germany took the lead in this direction from an early date. In many parts of the United States the same course has been adopted and the laws regulating the trade in commercial fertilizers in the different states agree with each other in the following points; namely, every package of material offered for sale for manurial purposes

must be accompanied by a plainly affixed guarantee stating the amount of nitrogen, or ammonia, potash and phosphoric acid contained therein.

Value of State Control:—The value of state control of fertilizers does not depend as much upon the law itself as it does upon the attitude of the enforcing official in planning the policy of the Bureau; in making known the advantages of state inspection, and by giving publicity to chemists' reports of analyses. Besides, the reliability and conscientiousness of the men drawing samples plays an important part in the work, and gives a feeling of confidence to both the purchaser and the manufacturer. State control discourages any attempt at placing inferior fertilizers upon the market, or claiming more for same than they possess, for through the means of chemical analysis, false claims are readily detected. Without the enactment of laws requiring publication

of chemical analysis of fertilizers, we could place little confidence in the quality of the goods purchased; for there is nothing in the appearance, odor or feel of a fertilizer that would indicate whether it is a worthless mixture or contains large percentages of available plant food. Therefore, the only safe and sane course to follow when purchasing fertilizers is to buy on the basis of plant food only, not on price per ton.

Danger:—Fertilizer brands sold in Ohio and falling below legal requirements are placed in the "Danger and Caution" column of the annual report. This method of advertising illegal goods has proven more effective against manufacturers than prosecution would be, for the reason that the former becomes of state-wide interest, while the latter is only known locally. The results attained have been quite satisfactory.



ROTATION OF CROPS

C. G. WILLIAMS

Agronomist, Ohio Experiment Station

THE practice of growing crops in an orderly succession is a very old one. We do not know who discovered that a soil which was worn out with respect to one crop would respond with renewed vigor when another crop was planted upon it. As a rule, it happens that when people go into a new country they are apt to continue growing the popular crops until the land ceases to yield a paying crop. Then it is that they are forced to consider the matter of rotation. Accordingly we find that in the older agricultural sections of our country better systems of crop rotation are generally practiced.

It is a wonder to many why the average yield of corn in Ohio is greater than in the better corn growing states further west. I think it is due to our better rotation systems; and as we go east the corn yields increase, probably for the same reason. It is true more attention is paid to the use of manures and fertilizers in the east, and this also figures in the result.

Reasons for Rotations:—There are a number of reasons why a rotation of crops is profitable, and the first one is that it enables one to keep up the content of organic matter better. The continuous growing of cultivated crops is very destructive of organic matter. Some of our best authorities tell us that more nitrogen is lost than is used. The upkeep of organic matter is greatly simplified where one grows clover or grass crops which yield heavy sods that may be plowed under for succeeding crops.

Rotation conserves fertility in that deep and shallow-rooted plants may be alternated, thus feeding from different

soil levels. The deep-rooted plants not only secure food beyond the reach of the shallow-rooted, but they leave much plant food behind in their decaying roots and stubble. There are also some temporary benefits from the deep-rooted plants in the way of better drainage and aeration.

Rotation permits a succession of crops requiring plant food elements in different proportions. The mineral elements are being gradually liberated by natural processes, and if called for in different proportions, all-round larger production will result. An average crop of clover, for instance, calls for about four times the potassium that the wheat crop requires, though these crops average about the same in their phosphorus requirements. Furthermore, a crop of sugar beets calls for about the same amount of nitrogen that the corn crop (grain) requires, but it needs about eight times the amount of potassium.

Rotation keeps the soil in better tilth; continuous cropping results in a sad, lifeless soil. Productive soils are full of life—bacterial life of the right sort. Soils vary from a few thousand bacteria per gram to many millions.

Rotation avoids many troublesome bacterial and fungus diseases—diseases that get the upper hand in continuous culture. What potato growers have not experienced the difficulty of growing good, clean potatoes continuously in garden soils? Potato scab will live over for several seasons in the soil and a soil once filled with it will not produce a clean crop until some years have elapsed. Our cabbage growers have their troubles with the club root

and the onion growers with smut. There are but few crops which are less subject to disease if they are grown in suitable rotations. Professor Bolley, of the North Dakota Station, has well said: "Each plant disease is special in its wants and cannot increase in the absence of its host."

Rotation gives greater freedom from insect pests. Many insects cannot migrate readily from one field to another and if the crop is removed they must perish. We suffer enough from troublesome insects even now with good attention to rotation.

Rotation helps the farmer in his battle with weeds. Each crop has its "besetting" weeds. In our continuous meadows and pastures in northern Ohio and New York we have a fight with the ox-eye daisy and Canada thistle. These weeds often get full control. It is only as such fields are put under clean cultivation every three or four years that these pests can be held in check. The great pests of clover fields, that is where a seed crop is produced following the hay, are narrow plantain and wild carrot. They may be given a serious setback by plowing and clean culture after the first crop. In the continuous oat field of the Ohio Station, bindweed pretty nearly ruined the crop a few years ago. At that time this was practically the only place on the Station farm where it had ever given any trouble, and the location of this particular field was such that one would hardly have expected any trouble there. We read of the continuous growing of wheat at Rothamsted, England, for some seventy years, and at first thought it may seem to "give the lie" to what I have been saying, but the facts in the case are that without hand-hoeing each year this wheat would have perished long ago, so foul has this land become

under continuous cropping. There are corn fields in this and other states that have been kept in corn for a good many years — fields that are so located that their fertility is kept up largely by flooding, but it is notorious that such fields are the homes of many species of weeds. By intelligent systems of rotation the problem of weed destruction may be greatly simplified.

Another advantage resulting from rotation lies in the fact that the land is kept occupied. In continuous cropping the land loses much from a failure to be occupied. Corn fields, for instance, suffer losses of nitrates during the months of September and October. Where wheat is immediately sown in such fields, a saving is obtained. Continuous wheat fields are usually bare, save for weeds, from the first of July to September. Under proper rotations a clover crop is ready to take the land even before the wheat is removed.

Rotation is especially valuable in that it systematizes the work of the farm, distributes it over a greater period of time and provides work more nearly the year round, thus balancing up the farm work. In this way one is able to hire help by the year instead of by the day or month, and can accordingly secure more desirable help.

Rotation may be regarded as an insurance against serious losses from natural calamities, such as floods, hail storms, drouths and frosts. The man with one crop loses everything in the event of such disaster. The man with a complete rotation seldom will lose more than one of the lot. This same insurance operates against serious losses from market fluctuations. If there are low prices resulting from great yields in this or in foreign countries, it is seldom that more than one crop is affected.

So much, then, for some of the reasons why one should rotate crops. If these reasons are well founded, we should expect a higher level of crop production. Where rotation is practiced we should expect to obtain larger yields and maintain such yields year after year. Is this the result of crop rotation as a general rule?

Attention is called to the following table, which gives the results of Rotation vs. Continuous Cropping with Corn at the Ohio Station:

ROTATION VS. CONTINUOUS CROPPING.
Fifteen Years' Work With Corn.

System.	Treatment.	Application per Acre.		Average Yield per Acre by 5-Year Periods—Bushels.		
		Per Crop.	Per Period.	First.	Second.	Third.
Continuous	None .....	.....	.....	26.3	16.8	10.4
Rotation (5)	None .....	.....	.....	31.9	30.8	31.1
Continuous	Manure ..	5 tons ..	25 tons ..	43.1	40.1	34.6
Rotation	Manure ..	4 tons ..	8 tons ..	38.9	43.1	50.3
Rotation	Manure ..	8 tons ..	16 tons ..	40.7	49.5	59.8
Continuous	Com. Fer.	420 lbs....	2100 lbs. ..	44.6	47.2	38.5
Rotation	Com. Fer.	320 lbs. ..	1070 lbs. ..	41.3	49.9	54.1

Recording these yields in 5-year periods it will be noted that under continuous culture, without the use of any fertilizer, the yields declined from a 5-year average of 26.3 bushels per acre for the first period, to 10.4 bushels in the third period, whereas, under a 5-year rotation of corn, oats, wheat, clover and timothy the yield for the three 5-year periods has remained practically the same. Where manure has been used in each case it will be noted that in spite of the application of 25 tons of manure per 5-year period the yield, under continuous cropping, declined from 43.1 bushels per acre the first period to 34.6 bushels in the third period. Under rotation, with only 16 tons of manure per 5-year period the yield, while a little lower for the first period (40.7 bushels), owing likely to the smaller amount of manure, advanced to 95.8 bushels in the third period.

Similar differences have also been obtained in the use of commercial fertilizers. One-half the amount of commercial fertilizer has resulted in a decided gain in yield, comparing the third period with the first. Whereas, under continuous cropping the yield has declined in spite of the use of double the amount of fertilizer.

Similar results have been obtained in the growing of wheat, the yield declined from 10.1 bushels to 6.2 bushels in continuous culture, while it increased

under rotation from 9.3 bushels to 13.7 bushels, no fertilizer having been used in either case. The results in the use of manure and commercial fertilizers are practically the same as in corn.

Similar results have been obtained by the Illinois Experiment Station. After twenty-nine years work we find the continuous corn yielding 27 bushels per acre. Under a rotation of corn and oats the corn yield is 43 bushels; with corn, oats and clover the yield increases to 59 bushels. The addition of clover to corn and oats is therefore worth 16 bushels of corn per acre.

The value of a good rotation system must be conceded by all. It must be remembered, however, that it is only one of several factors which have to do with successful farming. Rotation, alone, will not maintain fertility. As a matter of fact, it greatly increases the exhaustion of the mineral elements of the soil.

THE PURPOSE OF A SOIL SURVEY

GEORGE N. COFFEY

In Charge of Ohio Soil Survey

THE value of trained direction is being appreciated more and more every year; in agriculture as well as other lines of business. It was the recognition of this principle that led to the organization of agricultural colleges and experiment stations, the primary object of which is to find out and teach the farmers the lines along which their energies can be most advantageously expended; to help them determine, among other things, how best to use and not abuse the most valuable of all resources—the soil.

As the work of these organizations progressed it became more and more evident that variations in local conditions often made general recommendations impossible, particularly when they related to matters having to do directly with differences in soils.

That soils do differ in their ability to produce crops is one of the most widely recognized facts in agriculture today. They may be watered by the same rains, warmed by the same sun, planted with the same seed, cultivated with the same care, in fact, treated exactly alike in all respects, but still, owing to inherent differences in the soils themselves, the yields secured upon one soil may be many times as great as upon another.

However, the fact that all soils are not adapted to the same kind or variety of crop, do not require the same kind of fertilization or cultural treatment, and are not suited to the same system of farm management, is not so generally understood, although both experience and experiments agree that the latter is just as true as the former. A few illustrations may serve to em-

phasize the importance of soil differences.

Perhaps the most striking example of the adaption of special crops to a particular kind of soil is the use of a muck soil for the production of onions and celery. Sugar beets, which proved a failure on the Wooster soil, are being grown very successfully on an entirely different soil at Paulding.

The variety of wheat, which does best at Wooster, has not been able to compete with some other varieties on a different soil at the Miami County farm. The variety of corn, which does best on the black clay loam on the Miami farm, yields less than some other varieties on the light colored clay loam on the same farm.

For twenty years duplicate fertilizer experiments have been conducted by the Ohio Experiment Station on the yellow-brown silt loam at Wooster and the gray, heavy silty clay loam at Strongsville. The following table, compiled from Circular 141, Ohio Experiment Station, shows the marked contrast in the relative effects of the three principal fertilizing elements upon the two soils.

From this table it will be seen that while phosphorus has had a slightly greater effect at Strongsville than at Wooster, potassium has given, if anything, a slight decrease and nitrogen only a slight increase at Strongsville, although both have given a very material increase at Wooster. The increase from the addition of nitrogen and potassium to phosphorus at Wooster has been more than sufficient to pay for the additional cost of the fertilizer, while at Strongsville the profits

RESULTS OF DUPLICATE FERTILIZER EXPERIMENTS ON TWO DIFFERENT SOILS.

Fertilizing Elements.	Average Value of Increase for Each Rotation.			
	Total		Less Cost of Fert.	
	Wooster	Strongsville	Wooster	Strongsville
Phosphorus	\$16.52	\$17.48	\$13 92	\$14 88
Potassium	5.73	— .17	— .77	— 6.67
Nitrogen	8.37	1.77	— 6.03	— 12.63
Phosphorus, potassium and nitrogen...	38.28	23.71	15.78	.21

have actually been reduced from \$14.88 to \$0.21.

The results of these duplicate experiments on two different soils show conclusively that, owing to fundamental soil differences, the fertilizer treatment, which is very profitable upon one soil, may be unprofitable upon another.

Some years ago I listened to a very interesting talk upon soils, made from an extension train, but in concluding his remarks the speaker said: "Now, gentlemen, I do not know whether what I have said will apply to your conditions or not, because I do not know the character of your soil."

Since many recommendations made to the farmer must be varied to suit local conditions, of which the soil is certainly one of the most important, the agricultural colleges and experiment stations have been more or less handicapped in their efforts to help the farmers by a lack of definite and accurate information in regard to the character of the soil in different parts of the state. For without such knowledge definite advise is often impossible, or, if given, may not apply. To supply this information in regard to the soils is the primary purpose of the soil survey. In short, as Dr. Russell, Director of the Rothamsted Experiment

Station has so well said, "The farmer's problem can be satisfactorily solved, and the manurial trials fully interpreted, only when a complete soil survey has been made."

The first soil survey in Ohio was that of Montgomery County, made in 1900 by the Bureau of Soils. Several other areas, including sections around Toledo, Columbus, Cleveland, Ashtabula and Wooster and Meigs, Coshocton and Auglaize counties were added from year to year, but at the end of 1910 only 4,540 square miles had been surveyed. At this rate it would take just about 100 years to cover the entire state.

Recognizing the fundamental nature and absolute need of this information concerning the character of the soil in every part of the state, the Ohio Experiment Station began, during the summer of 1911, a general soil survey of the state and considerable work of a preliminary nature was accomplished that season, although no actual mapping was done. Before the opening of the field season of 1912, arrangements were made for carrying on the work in cooperation with the Bureau of Soils of the U. S. Department of Agriculture, and a reconnaissance of the entire state was completed and the report will soon be ready for distribution.

While the information secured through this general survey will be of great value, it was not possible, particularly in sections where the soil is varied and agricultural operations intensive, to secure all the information needed through a general survey and, therefore, detailed surveys are being taken up. In 1913 a detailed survey of Stark County was made and, during the past season, surveys of Trumbull, Portage and Paulding counties, and also a portion of Geauga County, have been completed. Cooperation with the Department of Agriculture is being continued, each organization putting in an equal number of men; the idea being that the two institutions shall share equally the expense. It is proposed to push the work, as rapidly as funds will permit, until accurate detailed knowledge of the character of the soil, in every section of the state, has been obtained.

In making these detailed surveys it is, of course, not only necessary to go over all the roads but also to walk across the fields. By means of an auger about one and one-half inches in diameter and forty inches long the character of both soil and subsoil can be examined, and the origin, texture, structure, color, the presence or absence of lime carbonate, etc., determined, and the boundaries between the different types outlined on the topographic base maps, which are used for this purpose.

The boundaries between the different types must be actually traced as the surveyor goes over the ground. Sometimes, because of marked contrasts in the color or topographic position of the types, a boundary is very sharp and its outline easily located,

while in other cases one type merges gradually into another and many borings are necessary to determine where the line between them shall be drawn. There are always many areas, which are intermediate in character between two or more types, and good judgment is constantly demanded to decide how such areas shall be mapped.

While the distinction between different types must be based upon those differences, which are obvious in the field, all fundamental differences, which affect the growth of crops, are, so far as practicable, given weight in determining the different types. Those differences, which have been produced by artificial treatment, because they may be eliminated by a change in the method of handling the soil.

While a great deal of valuable and basic information will be secured in examining and mapping the different types, it is clearly recognized that much additional information can and must be secured by means of laboratory investigations and field experiments before the value of the soil survey can be fully realized. In fact, the determination and mapping of the different types of soil is only laying the foundation, which, though absolutely essential, is of no practical value until the house is built upon it. Chemical and mechanical analyses, pot and other laboratory studies should be made, the kinds and variety of crops, the methods of soil management, the systems of rotation, farm management, and fertilization best suited to every important soil type in the state, should be worked out. All these studies must be projected from the standpoint of the individual soil type if the best results are to be secured.

SOIL FERTILITY MAINTENANCE

J. F. HUDSON,  Ravenna, Ohio

THAT we maintain the fertility of our soil is not enough. We should not only maintain the fertility and keep up the crop yield, but we should increase it from year to year. To do this in a successful way there are three essential things that must be kept in mind.

The first is live stock, then legumes

When the animals are sold and they carry some of the phosphorus off in their bones, this must be replaced. It can be done easily and cheaply by adding ground phosphous rock to the manure. Where this is done there is little use of purchasing any commercial fertilizers. The time is soon coming when our land owners will realize more



AN IMPORTANT CONSIDERATION IN MAINTENANCE OF FERTILITY IS LIVE STOCK.

and humus. In the past men have been so interested in growing crops of corn, wheat, oats and other grains and selling them for cash crops that they hardly realized the crop yields were decreasing until there was little or no profit. However, if the crops are fed to live stock and the manure is hauled directly to the field or kept under shelter on a cement floor, there is very little loss in fertility on a farm of this kind.

and more that by feeding their crops or by the purchase of additional feeds that they are buying the most expensive elements needed for fertility. When the Holland or Danish farmers buy our oil and cottonseed meal they estimate that they are getting two-thirds of the price of the grain in nitrogen, phosphoric acid and potash for maintaining the fertility of their soils. The time is also coming when the value of the feeds

carrying a high protein content will be considered by the dairy farmer here, so as to make the exports of these feeds too high priced for the foreign farmer. The protein in the feed carries a correspondingly high nitrogen content in the manure, as this is the most expensive element of fertility we buy, it will be appreciated very much more.

The writer has just returned from a trip through the cotton fields of the South. At the present time there is little sale for cottonseed meal and while reading a Southern farm paper the following editorial was noticed:

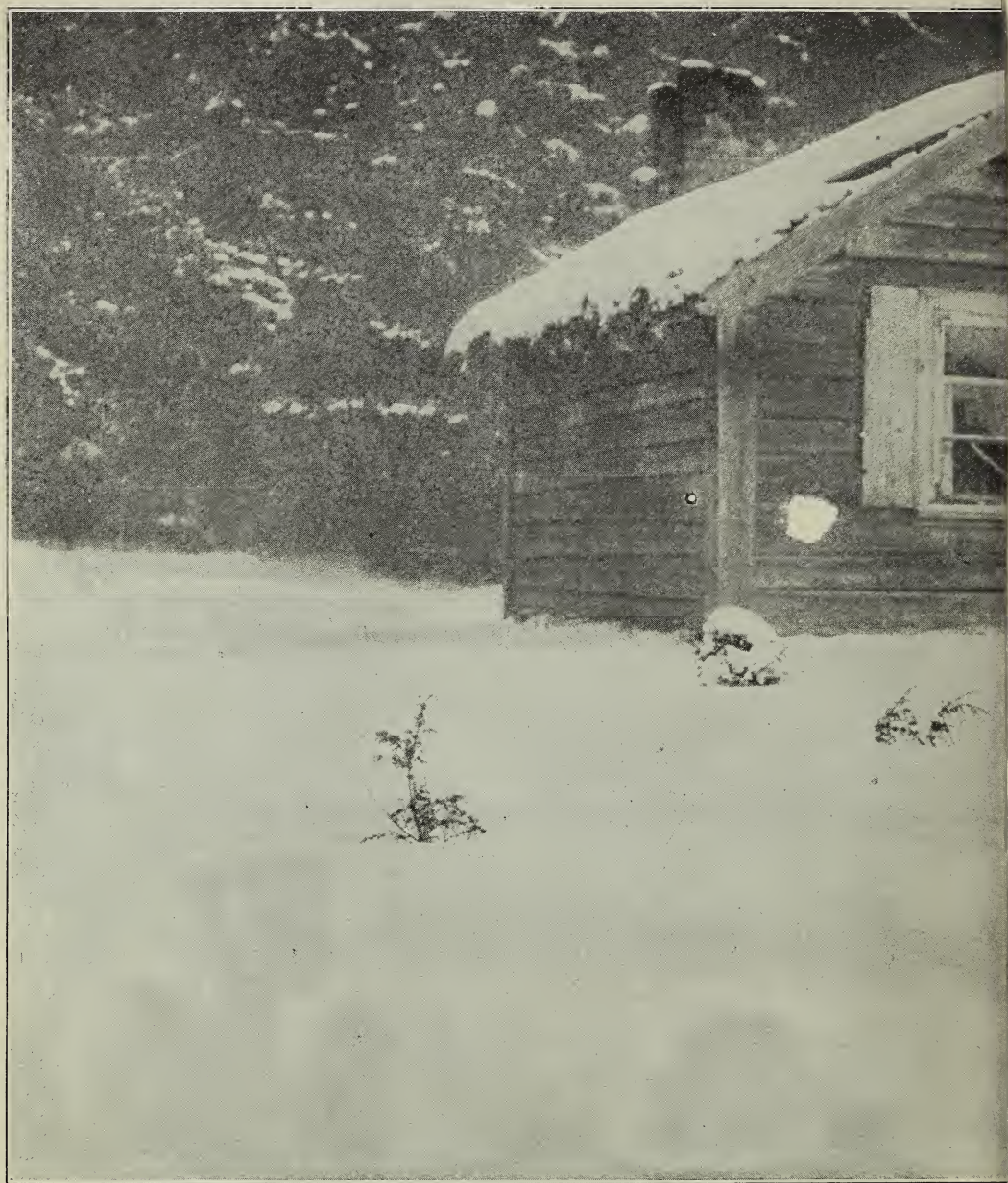
"The Southern farmer should buy cottonseed meal and spread it over his fields for fertilizer. At the present price of \$22 it is the cheapest fertilizer he can buy." Yet in the North we think the freight added to the purchase price make it cost too much and so one of our best feeds is not fully appreciated.

Men go to Alaska and Klondyke in search of gold. They endure all the hardships of extreme cold weather and exposure, yet the manure on the farms in the United States has a greater value than all her gold mines. Yet how carelessly the former is handled and how much is allowed to leach away and waste. The cash value of the by-pro-

ducts of every horse, cow, and pig should be estimated in the assets of every farm.

Legumes are our greatest asset. Corn has been crowned king and is one of the best crops for the American farmer to grow. Yet we could take the corn crop from the face of the earth and we could still live and prosper. We could take the wheat crop off the face of the earth and still get along. But take the legumes off and it would only be a question of time until we would begin to suffer and starve. Clover and alfalfa are appreciated more today than ever before and yet have hardly been given the credit that is due them. With the legumes we are able to add more nitrogen and humus more quickly and cheaply than in any other manner. As both live stock and legumes can be grown profitably, and if the manure is carefully handled the humus will naturally increase the producing power of our soil, so with these three essential factors continually in mind it will only be a question of good management for putting them into practice in the daily operation on the farm. Then the crop yields will not only be maintained but will increase from year to year until we have an average as high as the foreign farmers could under similar climatic conditions.





Progress and prosperity begin with the pioneer. Whether in the things of earth, or the things of the spirit, the pioneer blazing the way by bitter efforts, lays out the paths which mankind, later, follows with ease. Yet the pioneer knows true happiness and true peace.



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His happiness lies in the satisfaction of successful accomplishment. His accomplishment—the result of courageous conflict with the elements, the forest, the land—lays the foundation for that peace of soul that comes from reverent contemplation of the splendors of nature.

THE MANURE SPREADER AND ITS CLAIMS TO FAME

DOUGLAS MALCOLM

Of the International Harvester Company of America

WITH the exception perhaps of the wagon, farm machines as we know them on a modern farm are historically unhistoric. Steel plows date their natal period only back to the early part of the nineteenth century. Reapers first saw the light in the thirties, but did not come into common use until the fifties. Mowers appeared on the scene a little later. Automatic binders were first invented in the seventies, and along about that time came the first successful manure spreader.

Late, however, as this was in the history of the world, it was only within forty years of the first patent for the first idea of spreading fertilizer automatically. The records at Washington show that two brothers living in Philadelphia conceived a machine for spreading dry fertilizer about 1830. This was merely a cart with the bottom inclined rearwards and a transverse opening running along it. A belt passed around one of the wheel hubs operating a roller which helped to drive the fertilizer through the opening. Eight years after a New Jerseyite mounted a long cylinder of wire rods on wheels constructed in such a way that as it moved over the ground the fertilizer would fall through the cracks on to the soil. In 1850 a North Carolinian undertook to place a box upon rollers, using a flexible apron from the rear of the box over the rollers to form a flexible bottom. When this box was filled with manure the vehicle, by the friction of its motion, would work the apron back and forth, thus causing the contents to drop little by little out of the front of the box. This movable apron is still a part of

modern manure spreaders. In the sixties a man named Stevens of New York brought out another spreader with an endless flexible belt as the floor of the wagon box, so connected that as the wagon went forward this broad belt would go backward and deposit the manure in the rear, very similar to the endless belts for conveying light weights found now in our factories.

Other minor steps occurred until 1874, when Joseph Sensenig, a Pennsylvanian, brought out a patent not much unlike the cruder forms of our present-day spreaders. He had a flexible traveling box which forced the manure backward. In the rear of this box was a cylinder armed with flat pins which revolved. This is the second principle which has been retained in modern machines.

In all that had been done thus far there had been no spreader produced in this country that provided a mechanical means for disintegrating and pulverizing the manure or cutting up corn cob, stalks and straw. In 1875 J. S. Kemp, a Canadian, designed and patented a device which would perform this operation. One year later another Canadian named Thomas McDonald devised a similar machine. Two years later Mr. Kemp patented a complete spreader in the United States. In the rear of his spreader box was a rotating tooth drum which spread evenly the load on the ground behind.

A manure spreader as it stands back of the barn after it has done its duty toward the human race is perhaps the most permanently valuable machine in the entire farm equipment. Its daily use will not only guarantee any given

tract of land against depreciation, but year by year augment its fertility and add to its producing power. This truth is readily accepted in the classic halls of agricultural colleges and is well believed by intelligent manure spreader owners, but it is yet not universally used by the rank and file of farmers. It depends largely for its standing in the community upon the endorsement given to it by the scientifically trained agronomist. It is not to be expected that every man will understand the chemistry of the soil. He may know roughly that a plant depends largely

of fresh horse manure contains five pounds of nitrogen and three and one-half pounds of phosphoric acid. A similar weight of cow manure contains three pounds of nitrogen and two and one-half pounds of phosphoric acid. This includes both the liquid and the solid manure. In fact, the liquid manure is the more important of the two and one of the main uses of the spreader is in its way of saving this. For instance, where there is a spreader on the farm, absorbent bedding, such as shredded stover or straw, can be used bountifully enough to absorb several



A COMMON WASTE OF A VALUABLE PLANT FOOD.

for its sustenance upon three things, namely, nitrogen, phosphoric acid and potash. He may have learned that where these foods are easily available we have good crops, and where they are absent or locked up in dry, heavy earth the plants starve. He may not, however, know the importance of placing this plant food in or over the ground in such a way that the plants can make use of it. Then, again, he may not really realize how perishable this food stuff is when exposed to rain, wind, snow, and other climatic conditions.

Under ordinary averages a half ton

times its weight in liquid. A spreader easily pulverizes this, so that when it rots in the soil it only liberates the plant food which it has sponged up, so to speak, but at the same time liberates a large amount of the same kind of food which is a part of its own chemistry. One ton of straw, for instance, contains sixteen pounds of nitrogen, four pounds of phosphoric acid, twenty-six pounds of potash, and nine pounds of lime. These figures, however, are averages, as some manures and some straws contain much more plant food than this.

To illustrate how important it is that

none of these plant foods should be wasted, land raising a crop of about 20 bushels of wheat per acre will lose during the year twenty-seven pounds of nitrogen, twelve pounds of phosphoric acid and eighteen pounds of potash. If this wheat were able to get its eager talons on more of this food, the average would be more than twenty bushels. If it were unable to get this amount, the average would be less than twenty bushels. Hence, the easier the farmer makes it for his growing plants to forage, the better crops he can assure himself. He fattens his crops just as he fattens his steers. If, as they do in some parts of the country, he proceeds to fatten his corn or his oats on commercial foods and buys nitrate at 15 cents per pound, phosphoric acid and potash at 5 cents per pound, he can compute on this basis that barnyard manure, if properly conserved and properly spread, is worth \$2.21 per ton, cow manure \$2.02 per ton, and pig manure \$2.29 per ton.

It seems, thus, that saving the product of the stable lowers the high cost of plant living considerably, when we consider that twenty 1,000 pound cows will give one hundred and forty-six tons of manure in six months. To be strictly accurate in the cash value of a product generally considered a little better than worthless, for every 1,000 pounds weight of stock, whether horse, cow, or swine, the manure each year is worth from a horse \$27.74; from a cow \$29.27; and from that weight of hogs \$60.00.

That is, however, if it is saved right and used right. It has been estimated in regard to this that the way manure is handled by the farmers of this country wastes more than it takes to pay the taxes of all the farm lands in the United States.

There are two main leaks or avenues of dissipation in connection with this food supply of plants—first at the stable, and second in the field. Just as one can ruin an otherwise good hay crop by not handling it right, so one can damage a good manure crop.

Manure is at its best when fresh and is sensitive to several demoralizing influences. It cannot stand rain because water leaches the best part of it away; it cannot stand dryness because it ferments and the nitrogen is lost; in fact, it cannot stand at all. Fresh manure should be spread fresh.

The manure found in the barnyard in the spring or that found in little heaps in the field is only about half as good for plant food as the same manure would have been had it been pitched on a spreader from the stable and scattered over the land as soon as the load was complete.

In an actual government test, high-grade horse manure worth \$2.80 a ton went down in value \$1.74, or 62 per cent, by being exposed to the weather in little heaps; cow manure with the same test lost 30 per cent of its original cash value. Next to spreading it fresh, the important thing is to spread it finely pulverized and to spread it evenly. This must be done with a mechanical fertilizer, because the hand that wields the fork from the wagon top can do no more than scatter it in chunks.

The biggest and richest farmer America has ever produced is quoted as saying in regard to the manure spreader: "It is the most efficient money maker on the place." He farmed thousands of acres of land and had invested thousands of dollars in equipment, but to the spreader he paid his highest tribute. His reason for this was based on the fact that the spreader not only increased the yield of his land per

acre, but it saved a valuable product which had hitherto largely been neglected, and it added a cash increase to the selling price of the land.

The simple function of the spreader is to spread the manure so that it can be deposited at the feet of the plant, ready for consumption. Lumpy manure leaves too much here and too little there, over-stimulating some parts and starving others.

A spreader can cover an entire acre thinly but evenly with only three loads, whereas it requires approximately twenty loads to cover the same area with a fork. The customary amount per acre is a cross between the economy of the spreader and the excess amount spread by hand. At least from eight to ten tons should be applied to each acre.

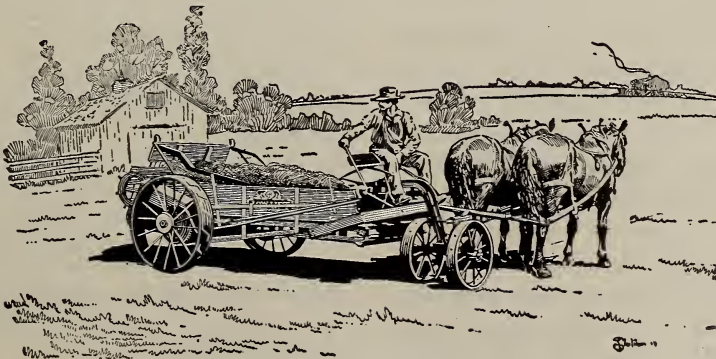
The manner of spreading manure is so essential to its preservation that the University of Wisconsin in Bulletin No. 221 claims that it is advisable to apply the manure to a field as soon as it is made. Even winter spreading is worth while.

It is equally preeminent in regard to pulverization. "To make itself worth while, manure must come in contact with the roots of the growing plants. To do this it must be thoroughly pulverized and evenly spread. The

practice of applying the manure directly after plowing, and thoroughly incorporating it with the soil by the use of a disk harrow or cultivator is a good one."

In 1877 Mr. Kemp did not know, we believe, the difference in value between thoroughly pulverized, fresh manure and lumpy, weather beaten manure. His primary object was to eliminate the drudgery and disagreeableness incidental to one of the most decidedly obnoxious tasks which annually thrusts itself upon the farmer.

To carry the barnyard refuse from the barn to a spreader in a litter day by day and to spread it economically and evenly over the fields without the touch of a human hand would have been considered second only to ordering their ascension robes by our grandfathers forty years ago. Even where there is no litter used, the work is so much less that a spreader will pay for itself in a fairly short period by the time it saves. Add to that the number of tons of manure it saves in the smaller requirements per acre and the increased yield resulting from more perfect pulverization, and it can be readily understood why the manure spreader is fast becoming as common a sight on our better farms as the time-honored wagon.



FERTILITY WITH AND WITHOUT LIVESTOCK

F. L. ALLEN

County Agent, Geauga County, Ohio

THERE seems to be more or less confusion over the term "fertility." Soils may contain all the elements of plant food in abundance, yet be unproductive. Others, according to chemical analyses may be deficient in one or all of these elements and produce good crops.

Fertility may be defined as "productive power." It does not depend upon plant food alone, but on conditions as well. The object of this paper is to study the effect of the livestock industry on the productive power of the soil.

Let us be open minded in our study of the question, and look at facts. Let us remember that while certain authorities are teaching that livestock farming is fundamentally necessary to a permanently fertile soil, yet the oldest agricultural lands in the world are sustaining the most dense population and that, too, without livestock. Let us remember that the oldest agricultural experiments in the world, as well as many of the best accredited investigations in this country, tend to show that livestock is not a necessity in fertility maintenance. Let us remember also that whenever anything that can be used for human food is converted into livestock products, there is an enormous loss of food values, and that as population increases and the problem of food supply becomes more acute, livestock products will furnish a constantly decreasing portion of the world's food supply.

Many things go to make up a productive soil. Plant food is necessary, but no more so than certain physical conditions. Suppose we take an average

corn belt farm, managed in a four-year rotation, producing 50 bu. of corn, 40 bu. of oats, 25 bu. of wheat, 2 tons of clover hay and 2 bu. of clover seed per acre annually. Then see what will be the effect upon the factors of production of a system of livestock farming in which all the crops are fed and used for bedding except wheat and clover seed, as compared with a system of grain farming in which all grain and seed is sold and all the coarse, bulky products are returned to the soil.

If all grain and seed is sold the loss of plant food per acre for the four years is as follows:

	Nitrogen, Lbs.	Phos. Acid, Lbs.	Potash, Lbs.
Corn, 2,800 lbs...	45.40	15.94	10.36
Oats, 1280 lbs...	21.20	9.83	6.54
Wheat, 1,500 lbs...	28.95	13.05	8.25
Cloverseed, 120 lbs.	3.66	1.34	1.62
Loss of plant food by selling.	99.21	40.16	26.71

If all crops are fed on the farm or used for bedding except wheat and clover seed, and assuming that 80% of the plant food is voided and all is perfectly saved, there is a loss of plant food as shown in Table II.

That is, there is a loss of plant food in selling in excess of the loss in feeding of 32.58 lbs. of nitrogen and 14.98 lbs. of phosphoric acid, but a gain of 7.25 lbs. of potash. This is assuming that all manure is perfectly saved and applied, which in practice is impossible. A loss of 1-5 of the voidings would destroy all the gain of plant food in feeding over selling.

	Nitrogen, Lbs.	Phos. Acid, Lbs.	Potash, Lbs.
Corn, grain, 2800 lbs.....	9.08	8.19	2.07
Corn fodder, 2000 lbs.....	4.14	1.16	5.60
Oats, 1280 lbs.....	4.24	1.96	1.90
Clover hay, 4000 lbs.....	16.53	4.48	15.12
Wheat (sold), 1500 lbs.....	28.95	13.05	8.25
Cloverseed (sold), 120 lbs.....	3.66	1.34	1.62
Plant food lost in feeding....	66.63	25.18	33.96
Subtracting the loss of plant food in feeding from the loss of plant food in selling, we have:	99.21 66.53	40.16 25.18	26.71 33.96
	32.58	14.98	-7.25

If we study the proposition a little closer, we find that the clover crop in root and top has gathered over 100 lbs. of nitrogen from the air, so that careful saving of plant food under either system will result in an increased nitrogen supply. And since there is a slight gain in potash in selling over feeding the only plant food loss in grain selling over live stock farming that we need to consider seriously is in the matter of phosphoric acid, which, as the figures show, is only 14.98 lbs. for the four year rotation.

But plant food is only one of the essentials of a fertile soil. It is generally held that the organic matter of the soil and its physical condition are of vital importance. If we compare the two systems as they affect the organic matter of the soil, we find that grain selling is decidedly preferable, for while it is possible to recover 4-5 of the plant food contained in the livestock ration, it is not possible to recover more than $\frac{1}{3}$ of the organic matter. The figures may be presented thus:

Pounds of organic matter lost from the farm by selling grain—

Corn 2800 lbs.
Oats 1280 lbs.

Wheat 1500 lbs.
Cloverseed 120 lbs.
Total 5700 lbs.

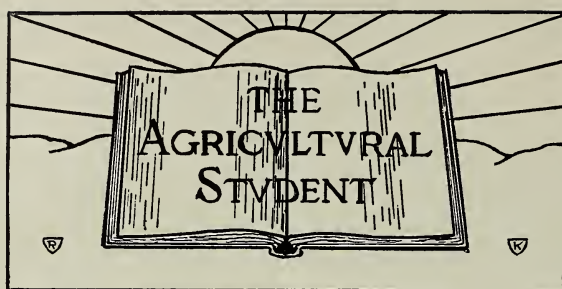
Pounds of organic matter lost by live stock farming—

$\frac{2}{3}$ of 2800 lbs. of corn..... 1866 lbs.
 $\frac{2}{3}$ of 2000 lbs. of corn fodder.... 1333 lbs.
 $\frac{2}{3}$ of 1280 lbs. of oats..... 853 lbs.
 $\frac{2}{3}$ of 4000 lbs. of clover hay..... 2666 lbs.
1500 lbs. of wheat (sold).... 1500 lbs.
120 lbs. of cloverseed..... 120 lbs.

Total lost by live stock farming.. 8338 lbs.
or a difference of 2,638 lbs. of humus-making material in favor of grain selling.

No one can uphold for a moment a one-crop system. And there is no doubt but that a careless system of grain growing will deplete fertility faster than careful animal husbandry; neither is there any doubt but that careless animal husbandry will reduce fertility faster than a carefully considered, closely followed system of grain growing.

I believe that permanent fertility is safer with the average man under live-stock farming than grain growing. But should one choose livestock it should be from preference or profit, rather than with the idea of fertility maintenance.



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COLUMBUS, OHIO, JANUARY, 1915.

EDITORIAL

When members of the Ohio Agricultural Commission had decided on the purchase of a farm for experimental purposes **A PREMIUM FOR FERTILITY.** in Clermont County, they found the owner very willing to sell for fifty dollars per acre even though he was only a few miles from the best markets in Cincinnati. In Paulding County, however, such a farm with no particular advantage as regards market facilities cost at the rate of \$175 per acre solely because of its unusual fertility. According to Director Chas. E. Thorne the soil on the Clermont County farm, if treated under the correct conditions, can be made just as productive as that of the Paulding County farm.

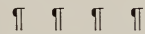
This illustration shows that a premium is always placed on fertility without regard to other conditions—high fertility being the first consideration in the purchase of any farm. Under good management, however, the cheaper land can be built up to a very productive state in a few years' time, the buyer realizing more on the money invested in the cheaper land than in high-priced land. High fertility commands a high price whether found in the most ideal spot for other farm activities or not, but so much emphasis is sometimes placed on it that the really economical and profitable opportunities are not realized. The wise farmer should always strive to bring the fertility of his land to its **highest economical production.**

Fertile soil is probably the best asset that a farm can possess. No other feature of the farm **INCREASING FERTILITY.** will return as much on the investment as that which has been added to make the soil more productive. This is well illustrated by the farm of the "city farmer" who having made his money from other activities, equips his farm with the best that money can buy. Such equipment scarcely ever returns a fair interest on the investment; but, in no case, even where the extreme was used, have such results come from any management which has contributed to increasing the fertility of the soil. In one instance, the owner of a large farm used 10 tons of limestone and one ton of acid phosphate to the acre, amounts which are regarded as extreme, but the soil which barely returned 4 per cent on the investment before now nets 16 per cent. The farmer can act no more wisely than to make all his farm operations contribute rather than detract from the fertility of his soil.

No one should feel, however, that poor soil is a serious drawback to the farm, for it has been proven that it is possible by proper management to build up the fertility and make good interest on the investment at the same time. A concrete example of this is shown by the "South Farm" at the Ohio Experiment Station, where a few years ago the soil was at the "exhausted point," but now crops of 36 bushels of wheat are raised instead of 10 and 12 bushels. The investment necessary to bring up the fertility from year to year paid very good interest; in fact, it was profitable for each crop to say nothing of the present condition of the soil. We should remember, also, that many of the European countries

have more than doubled the yields of their crops during the last generation and they are not regarded as especially excellent scientists when maintenance of fertility is considered. The lands in India which have been farmed for over four thousand years and which have been regarded worthless for agricultural purposes, by correct management and treatment in many places have been brought up to a high standard of fertility.

The farmer can do no greater agricultural crime than to leave the soil lower in fertility when he leaves it than when he first used it. On the other hand, he can do no better than to leave it better than he found it. The great factor in all agricultural activities is to leave the soil higher in fertility each year until the **economical** limit is reached.



Elimination of waste has been regarded as one of the greatest factors with which the **ELIMINATION OF WASTE.** farmer must contend. Often the loss

of the by-products is the great leak on the farm, for these are often wrongly handled or even discarded. Upon the complete utilization of their by-products great industries have been built and are maintained. The farmer can profit by their experience and use the same judgment in the control of the by-products which he is losing each year on the farm. He must take a lesson from his European brothers in conserving fertility.

Waste does not always come from the by-products alone, but many times from the uneconomical conservation of raw material into food stuffs. However, this is another question but it should receive as much consideration as the saving of the by-products. Every

farmer knows that manure is essential in the growing of better crops but, judging from the way many handle it, few realize its real value.

It is estimated by good authority that the yearly losses from manure from careless handling amounts to over \$40,000,000 for the state of Ohio. That is the amount which Ohio farmers would have to pay for fertilizer to replace the loss which results from allowing manure to be thrown into the farm-yard to be leached away by the winter rains. Drains from barnyards are often at the same time the important drains on the business. In short, waste may be regarded as that which results from a diversion from true economy and every farmer should strive to follow true economy in every farm operation.

¶ ¶ ¶ ¶

With the death of the Old Year comes the birth of the New. It marks the transition between our selfish, unsatisfactory past and our ambitious, hopeful future.

THE NEW YEAR. Its pages are clean and waiting for achievements in the line of progress. We loathe to post on these immaculate pages of the New Year entries such as crept into the records of the Old. We determine to sacrifice greed and selfishness for righteousness and purpose. We resolve to make this year ever better than the last.

Our ability to recognize and to correct our errors will in a large measure determine the joy and happiness to be gained in the successful achievements of the ensuing year. To some this will mean nothing but the continuation of

a life of pleasure and leisure; but to those who are young and full of life and vigor it marks another step nearer the goal of their ambitions. It is they who will meet the New Year with the slogan: "Give the World the best that is in you, and the best will come back to you."

¶ ¶ ¶ ¶

In the presentation of this number, the first of its kind ever published by any agricultural college magazine, we are greatly indebted to those men and corporations who have prepared articles and allowed us the use of certain illustrations. To them we extend our thankful appreciation.

Our cover page pictures the Executive Building of the Ohio Experiment Station where much of the great work along soil fertility lines in this country has been carried on. As Prof. Vivian has fittingly said "There is scarcely another man in the United States who has done more work in the advancement of Soil Fertility lines than Director Thorne of the Ohio Station." As students and farmers we can but partially express our appreciation of the wonderful achievements of the man.

We are indebted to Prof. Vivian for aid in preparation of this number and for several illustrations. Special credit is also due the International Harvester Company of America, the Jeffrey Manufacturing Company of Columbus, the Sharples Separator Company of West Chester, Pa., the Eastman Kodak Company, and the Extension Department of our own University.



"Happy New Year" sounded in your ear and you returned the same with a "Thank you." Who said it first, teacher or pupil? Perhaps the teacher said it the last day of school before Christmas vacation.

Now were these words backed by even a thought or a desire to make it a happier year, or was it merely the common place expression in keeping with the season of the year?

We have entered on the new year now and our tracks already reveal the chosen path. Have we remained in the old rut or are we wandering aimlessly on unfamiliar ground? Do our steps strike firm ground? Just to look into the face of the teacher who has realized his mistakes and has resolved to pilot his school into a brighter future reveals a smile which tokens a happier school room. It is all reflected in the lives of the pupils and when school is called to order in the morning things are ready to start. All through the day the teacher wears a countenance expressing that all is well and that things are at their best. Of course, a smooth path all of the time would lead us to believe that it was just a "happy-go-lucky" sort of school and that the teacher was scarcely creating an im-

pression indicating his presence in the community.

But these little unpleasant things which happen may be a lesson to both teacher and pupil as the former really analyzes the situation in such a way as not to only bring punishment to the wrong-doer but to prevent the same conditions from arising again. Then it is that the wish of Happy New Year is worth while, and the children enjoying school life are more easily molded into efficient citizens.

The other day a farmer's son made a discovery. He was standing in the open door of the barn, watching the falling sleet and snow when a new thought came into his mind. He had been studying feeding rations at school and now he wondered if there was really anything to it after all. Back into the barn he went to weigh the amount of feed he had been giving to Old Bos-sy. Yes, according to the weight of the milk he had been giving the right amount; but could he change the mixture of the feed a little and get more milk or would it pay to give the cow more feed? So his active brain figured that it would be profitable to do both, and he was able to prove it with the cow.

Few experiments, so interesting or practical as the feeding of animals, can be carried on out on the farm in connection with school work. Now that this is the time of year when live stock eat little except from the box and manger, it would be an ideal time to study feeding rations, providing the pupils are required to make comparisons with actual conditions and are not allowed simply to read over material in text-books and let the subject pass at that.

SOME OBSERVATIONS ON ACTION OF WATER ON SOIL

B. M. DAVIS, Miami University

THE surface of the soil is being continually changed by the action of water. Such action, called erosion, which takes place during or after a shower is familiar to everyone. The various effects of erosion are close at hand. When these effects are carefully studied by actual observation, the action of water on a large scale, such as wearing away mountains and depositing the material on lower levels to form fertile valleys, or the loss of soil, especially on the uplands, may be better understood and appreciated. The following simple observations on erosion may be readily made in almost any locality:

The Significance of Muddy Water.

Collect in a glass tumbler some muddy water from a swollen stream or from a mud puddle after a shower. Allow the water to stand until it becomes clear, and then pour most of it off without disturbing the sediment at the bottom of the tumbler. Leave the tumbler until the rest of the water evaporated. Transfer the sediment from the tumbler to a piece of white paper, scraping the material into a small heap. Compare the volume of this heap with the original volume of water held by the tumbler. The difference will be so great that the comparison will only be approximate but accurate enough for the purpose of this study. It is estimated that the material in the muddy waters of the Mississippi River if it could be collected for one year would make a column one mile square at its base and 241.4 feet high. This statement may be appreciated in part by estimating the amount of suspended material in a barrel of muddy water. First, determine the

number of tumblers of water in a gallon and then in a barrel; then make a heap of fine sediment as many times larger than the small heap as there are tumblers of water in a barrel. This will represent the amount of material held in suspension in a barrel of muddy water. Estimate the number of barrels of muddy water that would flow off an acre after an inch of rainfall, assuming that one-tenth flows off. Compare with the heap of soil which represents the amount of material held in suspension in a barrel of muddy water.

The Water in Action on the Soil.

All the erosive processes may be seen on a small scale on the slope of a road just at the end of a shower. Observe the following: How a small stream tears away small portions of its banks and carries the material away. How this stream meets other small streams where they flow together to make a larger stream. The effect of the larger stream tearing away the banks. The effect of pebbles or other small obstructions in the path of the stream. On the steeper slopes notice the bends of the stream and on which side of the bend the soil is being washed away. Note what happens on the other side of the bend. Following a stream to a more level region, notice the deposits made, locating the coarse and fine deposits and observing how the particles are arranged. Dig into a deposit to find if there is a difference in the kind of particles at various depths. Note the gullies worn in different places and the relation that the depth of these gullies bears to the slope or velocity of the stream. Estimate the amount of material carried away from a square yard of surface, and how much is deposited at the foot of the slope.

The Result of Erosion on Bottom Land.

With the previous observations in mind study a piece of bottom land through which a small stream flows. Follow the stream and notice its bends, meanders, and its deposits of sand and gravel. Examine the soil on the level above its banks. Compare this soil with the fresh deposits near the stream. Find evidences of changes in the bed of the stream. In time of freshets when the stream overflows its banks, what effect would the overflow have on the level ground covered with water? Imagine the effect of successive overflows, many hundreds, on the formation of the soil on bottom land.

The Result of Erosion on Bare Hill-Sides.

Find a bare hill-side (one on which no trees and little vegetation are growing) at the edge of a field. Note the gullies on the slope and those extending back into the field. Step off the distance that some of the larger gullies extend into the field. Count the number of gullies at the edge of the field 100 yards or more along the edge of the hill. Note how they interfere with cultivation. Estimate in acres the area of hill-side one-fourth of a mile long including the portion of the field ridged with gullies. Compare the production per acre on this area with that of the level parts of the field.

The Result of Erosion on a Wooded Hill-Side.

Find another hill-side, or a portion of this one which is heavily wooded. Make the same observations as were made on a bare hill-side, especially as to gullies running back into the field above. Make an estimate of the value of trees on the slope for one-fourth of a mile and calculate value per acre.

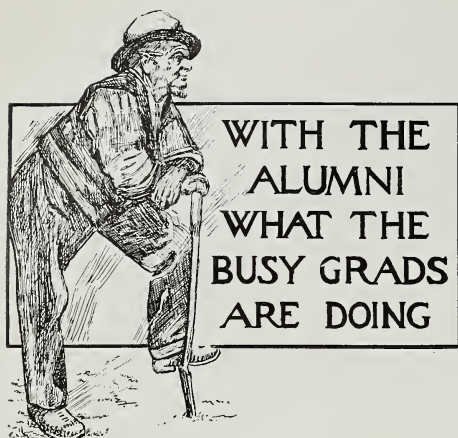
Compare with estimate made of production per acre on a bare hill-side.

Control of Erosion on Slopes and Hill-Sides.

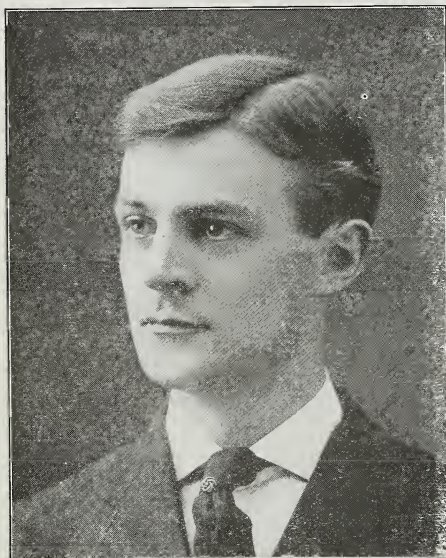
Work out a plan for reducing the erosion on a hill-side and making it at the same time of greater productive value. For suggestions as to quick growing trees suitable for fence posts and poles see bulletins relating to forestry of the Agricultural Experiment Station, Wooster, Ohio, and Forestry in the Public Schools circular 130. Forest Service, U. S. Department of Agriculture. Supposing that fence-post timber can be made ready for market in ten years and will yield fence-posts worth \$150 to \$200 per acre, compare with average land rental (cash) or money value of an acre of corn per year.

Application.

These simple observations and calculations are presented as concrete illustrations of a method of studying common every-day things which are frequently overlooked but which have much that is interesting as well as of real value. If these observations were made in the way indicated at least five things would be emphasized: 1, the great transporting power of water and the magnitude of its effects in the aggregate; 2, the results of this action in formation of soils in bottom lands; 3, the constant loss of land on unprotected slopes and hillsides; 4, the possibility of control of this action, reducing loss on the one hand and, on the other, making otherwise unproductive land valuable; 5, a concrete basis for intelligent reading dealing with large land areas, soil and forest conservation, etc. Incidentally studies of this kind in public schools furnish much material for application of arithmetic, and for interpretation of geography.



Firman E. Bear, '08, M. Sc. '10, now head of the Department of Soils at West Virginia University was born near Germantown, Ohio. After completing a course in the home school he entered Ohio State University, graduating in 1908. During the year of



1908-1909 he was instructor in agricultural chemistry; extension instructor in soils, 1909-1910, and assistant professor in agricultural chemistry, 1911-1913. During the summer vacation of 1908 he worked in the study of fertilizer control work. One summer

was spent at Cornell University studying chemistry and one at Wisconsin along similar lines. Additional graduate work in chemistry of soils for a doctor's degree was taken at the University of Wisconsin, 1913-1914. Mr. Bear has also made a careful study of the soil of West Virginia which will enable him in connection with his collegiate training to present valuable courses in his department.

R. R. Jeffries, '12, now extension instructor in West Virginia College of Agriculture acquired his taste for orcharding among the large apple orchards near his early home in Colorado. After spending four years in the Colorado Agricultural College he took up orchard survey work in the famous Bitter Root Valley of Montana. Several seasons were spent in the citrus fruit region of southern California. He came east in 1911 and identified himself with the Ohio State University where he took advanced work and also instructed in the horticultural department. Since 1913 he has been engaged in field experimental work and extension instruction for the West Virginia College of Agriculture and Experiment Station.

H. W. Nisonger, '14, is teaching agriculture in the high school at Bradford, Ohio.

J. E. Bowman, '14, is farming the home farm at Delphos, Ohio.

Tom L. Smith, '14, is teaching agriculture in Franklin College, New Athens, Ohio. He is also engaged in institute work and writes that he is having a very busy year.

A. L. Shebanek, '14, is dairy chemist for the John Wildi Condensery Company at Marysville, Ohio.

A. L. Turner, '14, is teaching agriculture at Bluefield Institute, Bluefield, Ind.

I. S. Cook, '06, was born and raised on a 1,200 acre farm in the Scioto River valley in Pike County, Ohio. After graduating from the Ohio State University in 1906 he took charge of this farm and managed it successfully for five years. While engaged in this work he supplemented his farm experience by giving instruction in the agronomy department of the agricultural college and later by giving the same kind of instruction in the extension schools of the state. Since 1911 he has been at the head of the agronomy department at West Virginia University and also has had charge of the soils and crops work at the Experiment Station.

True Houser, '06, now Assistant Botanist for the Ohio Agricultural Experiment Station, is located at Germantown, Ohio, where he is engaged in carrying out experiments in relation to tobacco culture. He is also connected with the U. S. Department of Agriculture, Bureau of Plant Industry, being collaborator to that department. He is the author of "Comparison of Yields of First Generation Tobacco Hybrids with those of Parent Plants," "Tobacco Breeding in Ohio," and "Certain Recent Results in Ohio Tobacco Breeding." He also contributes to the publications of American Breeders' Association and Ohio Plant Breeders' Association.

G. W. Bissell, ex-'16, was married during the recent vacation to Miss Mary White, of Kingsville, Ohio. They will reside on the Bissell farm where he will manage an extensive dairy.

Harry K. Thompson, who attended Ohio State University during '04-'05, is now farming near West Salem, Ohio. He is deputy for the grange organizations of Wayne County and takes an active part in furthering the activities of the Grange.

P. L. Sharitt, '14, is a dairy inspector for the city of Dayton.

R. L. Feddersen, '14, is an ice cream and butter manufacturer at Bellview, Ohio.

H. C. Baumgardner, '14, is an assistant in the animal husbandry department at Illinois College of Agriculture, Urbana, Ill.

T. R. Shivley, '14, is engaged in state geological survey work at Carey, Ill.

Harrison Davis, '14, is farming at West Milton, Ohio.

F. P. Tracy, '14, is a fruit farmer at Euclid Village, Ohio.

C. B. Harpster, '14, is a bacteriologist and chemist for the Moore and Ross Milk Co., Columbus, Ohio.

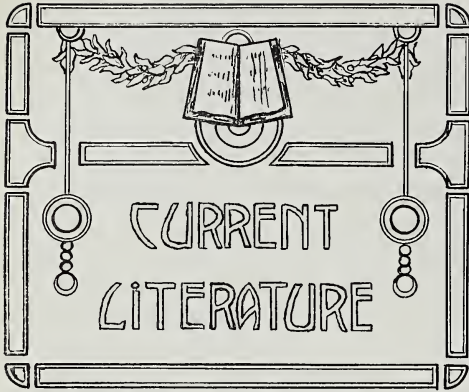
W. I. Geissman, '14, is a teacher in an agricultural school at Waterloo, Iowa.

S. W. Durrell, '14, is operating a stone and lime quarry near Mackinaw City, Mich.

C. W. Holdson, '14, is dairyman for the Boys' Industrial School, Lancaster, Ohio.

V. C. Smith, '12, secretary of the Agricultural College and assistant to Dean H. C. Price was married to Miss Ethel Foote, '12, on December 16, 1914. They will live on West Eighth Avenue.





"Swine in America," by F. D. Coburn, Secretary Kansas Department of Agriculture. This book gives a very comprehensive treatise on the great swine industry. Every phase of hog raising is considered from a practical standpoint, and the latest contributions to the science and art of managing and handling hogs weighed and discussed. Facts relating to the swine industry, as they have been determined by years of practical experience and scientific investigations are presented in such manner as will be most beneficial to breeders, feeders, and students. 650 pages, well illustrated. Price, net, \$2.50. Orange Judd Co., New York.

"Insects Injurious to the Household," by Glenn W. Herrick. Apparently the more complicated and pretentious the habitations and domestic arrangements of man become, the more persistently he is accompanied by unwelcome guests from that great group of unnumbered animals and insects. This book aims to give a concise description of the appearance, habits and injuries of these small inhabitants of the dwelling houses, together with a rather extended discussion of methods of controlling them. Numerous illustrations of the insects and their work will add greatly in identifying the

pests with which the reader is concerned. 470 pages, net, \$1.75. The Macmillan Co., New York.

"Fights of the Farmer," by Alva Snyder. The purpose of this book is to tell in practical, concise language how to fight the vital agricultural battles that every farmer must face, such as the loss of soil moisture and soil fertility, fighting the wind, soil erosion, the frost, the weeds, the insects, farm waste, etc. The pages will be instructive to the general reader and will be a guide to the farmers and teachers generally. 234 pages, illustrated. J. B. Lippincott Co., Philadelphia.

"Sheep Feeding and Farm Management," by D. Howard Doane is a book written primarily as a reference book for students of agricultural colleges. One of the distinctive features of the book is that it was written after a thorough investigation of sheep feeding and farm management. It also contains information on the best ways to market sheep. 128 pages, illustrated. Cloth, \$1.00. Ginn and Co., New York.

"The Principles of Breeding," by Eugene Davenport, Dean of the College of Agriculture of the University of Illinois, is the most comprehensive work of its kind ever written. The author's experience in the laboratory and on the farm enable him to understand the problems of the breeder and to present them in the light of the latest biological science. The aim has been to treat the subject so that the book can be used as a college text, and at the same time be adapted to the practical breeder on the farm. 727 pages. Cloth, \$2.50. Ginn and Co., Boston.

"Making Religion Efficient." This work is edited by Clarence A. Beerbour, D.D., the various chapters being written by specialists in each phase of the work of which they write. The Men and Religion Forward Movement has placed a new responsibility upon the Christian churches of America and this work is intended to be a handbook for the use of pastors and Christian workers as it brings together the statements of men of wide experience in all departments of church and social work. 271 pages. Cloth, \$1.00. Associated Press, New York.

"Soil Fertility and Permanent Agriculture," by C. G. Hopkins of the University of Illinois, is distinctly a book of the times. It teaches that the common practices of American agriculture are leading toward land depletion. To prevent this depletion the book gives figures showing the composition of soils in various parts of the country, investigates their condition, and explains the processes by which they may be brought to their highest productivity. 653 pages, illustrated. Cloth, \$2.25. Ginn and Co., Boston.

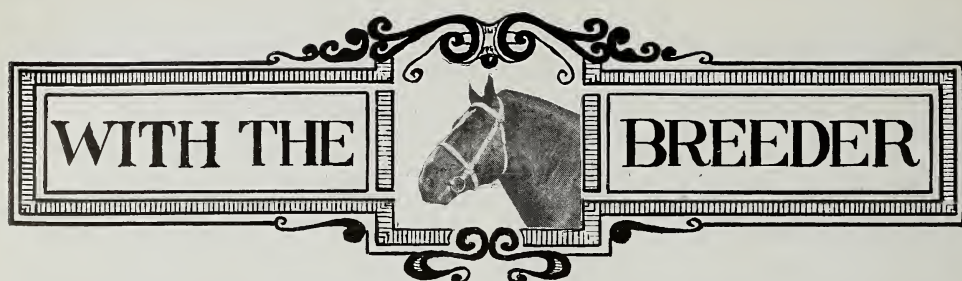
"Profitable Stock Feeding," by H. R. Smith, Professor of Animal Husbandry in the University of Minnesota, contains a vast store of personal experiences along with the latest teachings in the agricultural colleges. After a discussion of the general principles of feeding, milk production, beef cattle, sheep, horses, swine and poultry are treated in a thorough manner. The text is invaluable to the farmer and student. 413 pages, illustrated. Cloth,

\$1.50. Webb Publishing Co., St. Paul, Minn.

"Country Church and Community Co-operation." This volume is the third of a series pertaining to the country life movement that have been edited by Henry Israel. The matter here presented contains papers and recommendations by a commission especially appointed of which Prof. T. N. Carver is chairman. This work should be of real value to all who are interested in the betterment of our rural citizenship. 170 pages. Cloth, net, \$1.00. Associated Press, New York.

"Home Pork Making," by A. M. Fulton. This work furnishes in a plain, simple manner, detailed information that is necessary to enable the farmer or country butcher to successfully and economically slaughter his own hogs and cure his own pork. All stages of the work are fully presented, inclusive of methods of finishing off hogs in the feedlot to methods of serving the pork on the table. 124 pages. Cloth, net, \$.50. Orange Judd Co., New York.

"Farm Animals," by T. F. Hunt and C. W. Burkett. In the preparation of this volume the authors have sought to treat in detail, not merely the subjects of breeds, breeding, feeding, sanitation, medication, and animal products, but to cover the whole field of animal industry. The book is designed primarily as a high school text for which reason frequent practicals have been inserted. 534 pages, illustrated. Net, \$1.50. Orange Judd Co., New York.



Tilly Alcarta, a five-year-old Holstein-Friesian cow owned by A. W. Morris and Sons of California, by her record production of 30,452.6 lbs. of milk containing 951.3 lbs. of butter fat, recently won for herself the title of the world's greatest milk cow of all breeds. Creamelle Vale formerly held the world's milk record with a production of 29,591.4 lbs. of milk in one year.

The daily grain ration fed Tilly Alcarta during the test consisted of five pounds each of oats, barley and bran, and 3.3 pounds of linseed oil meal. Nine pounds of corn silage, 9.3 pounds of dried beet pulp, and 41.5 pounds of stock beets per day contributed to the succulence, and 27.7 pounds of hay furnished the roughage.

Plans are rapidly developing for one of the greatest live stock shows in history to be held at the Panama-Pacific International Exposition. Sixty-five acres will be devoted to the live stock department and the live stock buildings will cost \$150,000. For convenience the buildings are grouped around a large arena where the judging will take place. Feed will be furnished to exhibitors at cost from a large feed storage building.

For the accommodation of stockmen the Transcontinental Freight Bureau has granted a one way freight rate on live stock for exhibition purposes. Under this arrangement all live stock

on which full freight rates have been paid to the Exposition will be returned free over the same route. If animals are sold and not returned twenty-five per cent of the freight charges collected will be refunded.

Cash prizes to the amount of \$175,000 have been appropriated by the Panama-Pacific Exposition on live stock. This added to the appropriations now brings the grand total of cash to be distributed in premiums to \$430,000.

As the International Percheron Futurities were not shown this year it was decided, at the annual meeting of the Percheron Society of America, that they will be carried over into next year and applied to the two-year-old division for those entered as yearlings. E. B. White, President of the society, will offer two one-hundred dollar cups, one for the stallion that wins the yearling futurity and comes back the next year and wins in the open two-year-old class, and one for the filly that makes a similar record. President White declared that futurities had shown the ability of American breeders to develop yearlings, and this offering was to test their ability to carry these youngsters on and make high class two-year-olds of them.

Farmers often fail to appreciate the value of roughage as a winter feed for brood sows and growing pigs. In

order to maintain the health and vigor of the herd and at the same time reduce the feed costs a store of choice legume hay should be provided. In some cases corn alone, or corn and rich concentrates are relied upon as a winter feed. Consequently unless they are fed in large amounts the ration will lack bulk and the hogs will be restless and quarrelsome. Corn is rich in starch and carbohydrates but low in lime, crude protein and mineral matter.

To furnish the required bulk and balance up the ration a daily allowance of legume hay, either good clean clover or alfalfa preferably of the last cutting will give wonderfully good results. Alfalfa clover not only furnish bulk and crude protein, but carry considerable amounts of lime and phosphorus which are needed for bone building. Corn supplemented with alfalfa or clover and a little skim milk makes an excellent ration for all breeding swine. The hay may be fed in racks or open boxes.

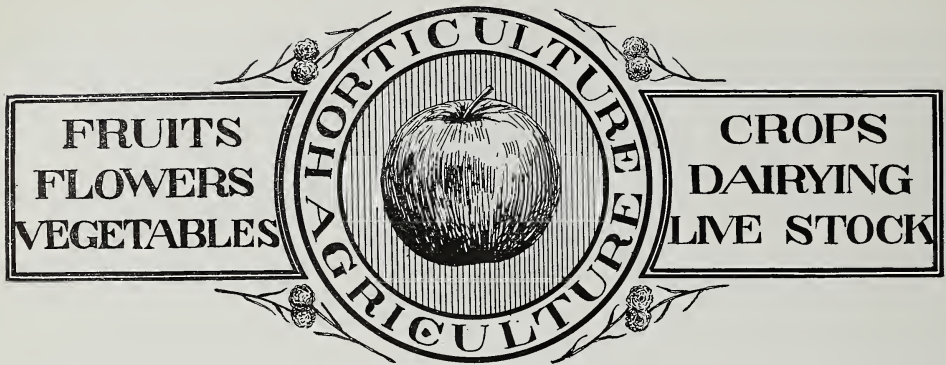
The annual auction sale of Percherons held at Gregory Farm, White Hall, Ill., December 8, by W. S. Corsa, proved that pure bred Percherons are still in great demand in this country. The entire offering of thirty-three stallions and mares brought a total of \$22,030. an average of \$640 per head. They

were mostly the get of the noted sire, Carnot.

Buyers attended from nearly every state in the union, Ohio being especially well represented. It will be of interest to note that nine of the thirty-three head will come to this state. Four stallions, Carmerica, Siguard, Locarno and Carfera, and two mares, Countess Carnot and Huchmine were purchased by A. W. Green of Middlefield, Ohio. A two-year-old mare, Carnolaide, went to Geo. A. Dix of Delaware. Carfera was purchased by C. E. Coyner of Delaware and Queen Carnot by E. Kirkpatrick of Cardington, Ohio. The introduction of this noted blood is expected to stimulate the Percheron interests in Ohio.

Representatives of the British and French governments have been making extensive purchases in eastern and central United States, of cavalry and artillery horses for use in the present European war. These buyers have been more particular and discriminating than was expected, since the life of the average army horse is estimated at only ten days. As was first anticipated this country will not be relieved of the bulk of her poorer class of horses. However, a stronger demand is looked forward to for light horses in the spring due to these exportations to Europe.





Trips to many farms and points of interest about the city, lectures on foreign lands and daily four o'clock lectures will be some of the features which are held in store for the students of the winter course which begins January 5. The enrollment in the course will exceed that of last year by about 50, making a total of nearly 150.

Due to the added facilities of the new buildings the four o'clock lectures and all lecture classes will be held on the campus this year; the laboratories in farm machinery, animal husbandry and dairying will be held at the state fair grounds.

Speakers for the daily lectures are as follows:

Jan. 5—"The Economy of Agriculture," Dr. W. O. Thompson.

Jan. 6—"What's in It" Chas. E. Snyder.

Jan. 7—"Alfalfa Culture," Joseph E. Wing.

Jan. 8—"Story of an Ohio Farm," Joseph E. Wing.

Jan. 11—"Our Annual Legumes," C. G. Williams.

Jan. 12—"Red Clover," C. G. Williams.

Jan. 15—"Essentials to Successful Farming" C. G. Williams.

Jan. 19—"Farm Power." C. M. Emerson.

Jan. 20—"Farm Handicaps—the Remedy," S. A. Harbort.

Jan. 21—"Work of Fish and Game Division," J. C. Speaks.

Jan. 22—"Agriculture in Normal Schools," W. F. Copeland.

Jan. 25—"Hog Cholera," Dr. Paul Fischer.

Jan. 27—"Better Live Stock for Ohio Farms," B. E. Carmichael.

Jan. 28—"Corn as a Feed," B. E. Carmichael.

Jan. 29—"An Ideal Rural School," H. L. Goll.

Feb. 8—"Brain Against Brawn," A. P. Sandles.

Feb. 9—"Work of the County Agent," M. C. Thomas.

Feb. 10—"Redistricting the Rural Schools," B. M. Davis.

Feb. 11—"Orcharding in Ohio," W. W. Farnsworth.

Feb. 12—"The Rural Citizen," J. F. Cunningham.

Feb. 15—"The Challenge of the Country," G. Walter Fiske.

Feb. 16—"The Rural Church Problem," G. Walter Fiske.

Feb. 17—"State Farming," Chas. E. McIntire.

Feb. 18—"Getting Acquainted," C. R. Wagner.

Feb. 19—"Commercial Orcharding," N. E. Shaw.

Feb. 23—"The Basis of Soil Fertility," Chas. E. Thorne

Feb. 24—"Commercial Fertilizers," Chas. E. Thorne.

Feb. 25—"Liming the Soil," Chas. E. Thorne.

Speakers and lectures for the special Monday evening lectures on foreign lands are as follows:

Jan. 5—"Belgium and France," Prof. Chas. S. Plumb.

Jan. 12—"Germany and Austria," Dean H. C. Price.

Jan. 19—"Egypt and Palestine," Prof. Alfred Vivian.

Jan. 26—"Denmark, Norway and Sweden," Prof. George Livingston.

Feb. 5—"Philippine and Hawaiian Islands," Prof. Alfred Vivian.

Feb. 9—"Ceylon and India," Prof. Alfred Vivian.

Feb. 16—"England and Scotland," Prof. Chas. S. Plumb.

Feb. 23—"China and Japan," Prof. Alfred Vivian.

Many prominent agricultural men have been secured to deliver addresses during Farmers' Week, February 1-5. Two or three of these lectures will be given each day together with the regular program.

Carl W. Gay, a former Ohio man, now professor of animal husbandry at the University of Pennsylvania and author of the text-book "Productive Horse Husbandry," will speak on Wednesday, February 3.

G. W. Montgomery, the crop specialist from Cornell University, will give his experiences and experiments dealing with corn improvement and breeding.

Dr. T. W. Duvall, an alumnus of the agricultural college and now in the U. S. Department of Agriculture, will discuss the storage, handling and grading of corn with respect to the recent corn grades which have been prepared by that department.

S. A. Beach, Horticulturist at Iowa State College, will deliver a lecture on the opportunities for orcharding and various horticultural lines which would be beneficial in Ohio.

Miss Elizabeth B. Kelly, who directs home economic extension work in Wisconsin, will give several lectures on that line of extension work on February 1 and 2.

Horace Atwood of Virginia will have special lectures on Poultry on Monday and Tuesday, February 1 and 2.

"Concrete on the Farm" will be treated by W. S. Shaw of Chicago.

On Wednesday noon, February 3, all the alumni and former students of the agricultural college will meet in Ohio Union for luncheon. Since this is held during Farmers' Week it will be possible for many to attend. The meeting was so successful last year that a yearly feature has been planned.

Murne Cowan, the Guernsey cow, now being watched with such keen interest, has already surpassed all milk records of the Guernsey breed. Her record for 299 days is 20,004.3 pounds of milk, exceeding May Rilma's yearly record by 331.3 pounds. Her fat production has reached 886.6 pounds. Barring all accidents until her year's record is completed she is destined to become the world's champion dairy animal. This cow is owned by O. C. Barber, Anna Dean Farm, Barberton, Ohio.

Crown Princess Maxie De Kol 2d, the Holstein-Friesian cow now holding the 30 day record in the senior 4-year-old class, has recently produced 8.34 pounds butter fat in two days; the milk tested 5.38 per cent fat. This cow is owned by G. W. Rising, Fayette, Ohio.

Winners of the Boys' Junior Contests in the corn, apple and potato county contests have been awarded scholarships to the three-year courses of agriculture by the Agricultural Commission. Three were not old enough to receive a scholarship and one girl, Mary Wherbuch, winner of the corn contest in Carroll County, will probably be granted a scholarship in the home economics department. Of the 86 county winners 49 raised over 100 bushels of corn to the acre.

The first student in the college of agriculture to win a place on the Varsity Debating Team is L. L. Rummell, senior in the four-year agricultural course. The other members of the two teams with their classes are as follows: A. S. Burket, Senior Law; George Bidde, Senior Law; J. W. Bricker, Junior Arts; C. F. Lindsley, Senior Arts, and R. W. Laughlin, Sophomore Arts. Burket and Lindsley are the only men left from last year's teams.

The annual debate with the University of Indiana will be held March 12, the question being: "Resolved, That the Federal Government should own and operate all telegraph and telephone lines within the United States."

Presenting agricultural education to those who find it impossible to attend the agricultural college or its extension school, through the medium of a correspondence course is a new feature of the extension work which is being prepared by J. E. McClintock, supervisor of publications for the extension department. These courses, which will be offered after September 1, 1915, will consist of special courses on such activities as fruit growing, vegetable growing, dairying and various other subjects.

Texts in pamphlet form will be prepared by the heads of the various de-

partments in the agricultural college and these, together with a list of questions, will constitute a lesson the answers to which must be returned by the student before the second lesson is sent. All correspondence on the course will be conducted by the extension department. No credit, however, obtained in the correspondence courses will be allowed to be entered for any of the regular courses at the college of agriculture.

Correspondence courses in agriculture are in operation in Massachusetts, Pennsylvania, West Virginia, South Dakota, Arkansas, and California. All have proved successful and California, starting but two years ago, now has over 10,000 enrolled in these courses.

The faculty and Board of Trustees recently passed a set of rules governing the system of accounting in student organizations through a University Auditor. The object of these rules is to prevent committees from contracting bills which their respective organizations cannot meet. By making the system of accounting uniform in all organizations, it is claimed by President Thompson that inspection by the University Auditor will be easy, and as a result will give every organization of the University greater credit among business men. According to these rules all records, books, blanks, etc., are to be secured from the University Auditor, who will audit all books and vouchers of all student organizations at least once each semester.

Dedication of the new Horticultural Building will take place during Farmers' Week. Dean H. C. Price, Pres. W. O. Thompson, Prof. W. R. Lazenby and A. D. Selby, of the Ohio Experiment Station, will take part in the exercises.



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Assembly Night for former pupils and friends, Thursday evenings, 25c. Fox Trot taught.

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Beginners' class organizes Wednesday evening, Jan. 13.

Tuition for Beginners—Gentlemen, per term of 10 lessons, \$5.00; ladies, \$4.00. Private lessons \$1.00, six for \$5.00. Tuition can be paid \$1.00 per week until paid. Private lessons can be had afternoons or evenings. The waltz, two-step, fox trot and one-step taught in one term.

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Quality Sprayers for every purpose. Man Power and Horse Power for field and orchard. Barrel and Power Sprayers all give high pressure and produce vapor spray that kills scale, prevents blight and scab, and rids your crops of all fungus and insect pests. Hurst Sprayers have brass ball valves and all the working parts that come in contact with the solution are made of brass. Cyclone agitation insures an even distribution of the spraying materials and best results. We guarantee our sprayers for **five full years and ship on free trial**—no money in advance. That's evidence of quality. Get our big **FREE BOOK**—"Why, How and When to Spray"—Contains 74 illustrations of insect and fungus pests and gives remedy for each. Also shows 30 different styles of quality sprayers for every purpose. Write At Once!

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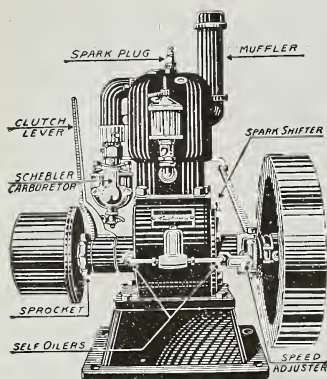
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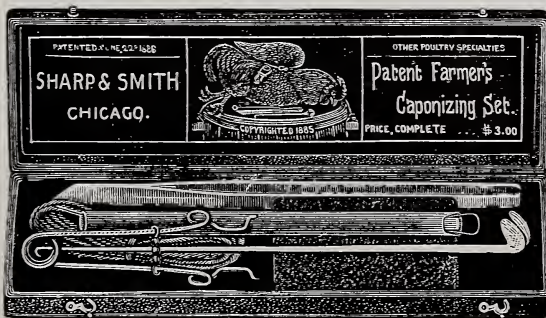
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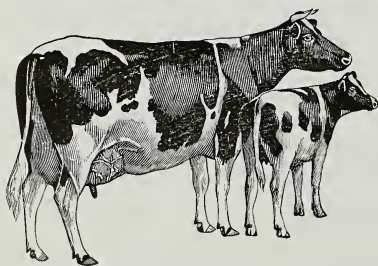
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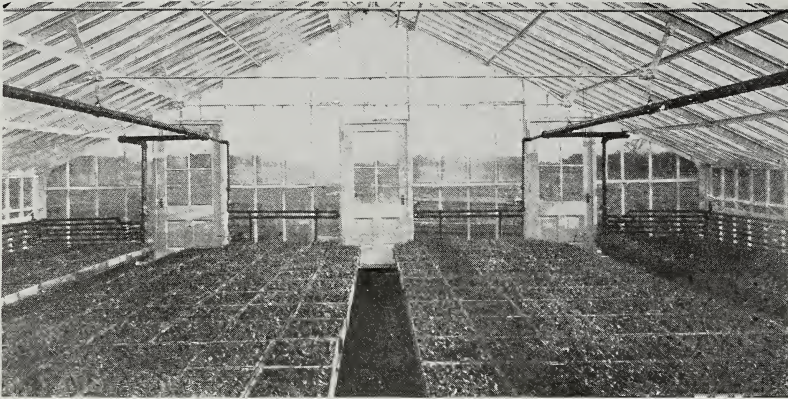
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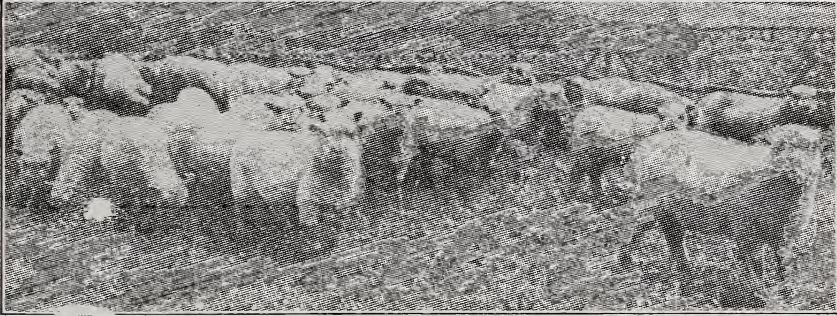
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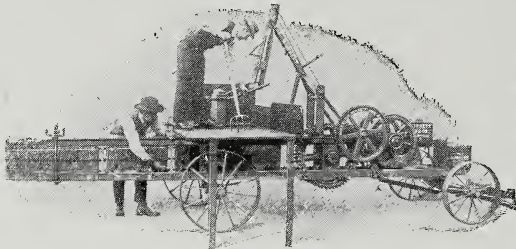
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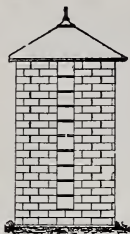
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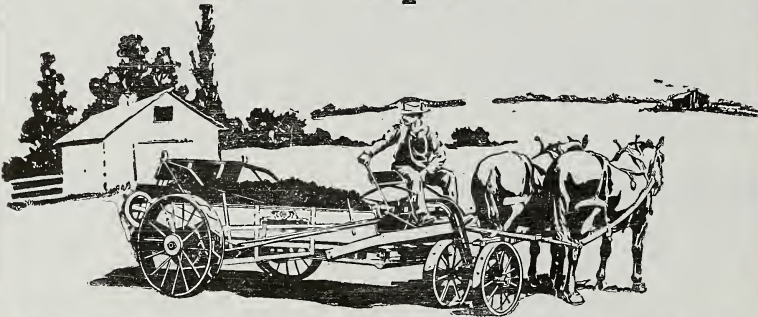
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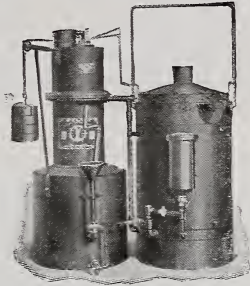
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